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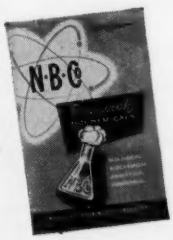

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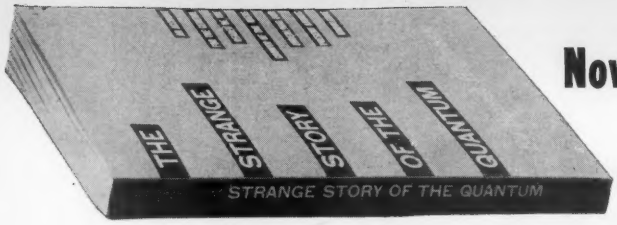

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Partial eclipse of the sun, New York, 2 October 1959. The picture was taken over Manhattan at 7:30 A.M. Eastern Standard Time. [New York *Times*]

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Letters

The Earthworm Theory

For partly personal reasons I would like to take mild exception to Morris M. Leighton's recent letter [*Science* **130**, 106 (1959)] expressing regret that the "revolutionary new concept of the ice age," as it was put in the newspapers, *was* put in the newspapers, partly because of a sort of unofficial wink from the editorial pages of *Science* [**128**, 1290 (1958)].

Not that I completely agree with the concept, which says that glacial till was dumped from icebergs floating on a vast periglacial lake, nor will I agree with the newspapers, since the "revolutionary new concept" dates back at least to Lyell (1835). On the other hand I'm sure everyone will agree that valuable service was rendered.

That is, by instilling precious doubt into the public mind, you automatically lend credence to another theory for the origin of the so-called glacial deposits, the Gigantovermiculous Coprolite theory, of which I happen to be the author.

My theory, which I now plan to entertain before the AAAS and have you preview on the editorial pages of *Science*, suggests that instead of having glaciers, which is a rather old scheme anyway, the Temperate Zones were periodically invaded by a slithering horde of earthworms. By a perfectly ordinary process of ingestion at one end and outgestion at the other, these animals ate solid rock and reduced it to a mixed, pulverized deposit merely by the work of their gizzards.

Major evidences for the earthworm theory are the widespread occurrence of the coprolite and the small scratches or striations common on surfaces of included pebbles. The latter are incorrectly attributed to grinding within the basal glacial ice; they are of course strain lines (*striae strainus*), indelibly etched as a natural consequence of the efforts of these little creatures to rid themselves of their gravelly excrement. Stones too large to swallow also show evidences of their gnawing appetites.

I shall now attempt to show that my theory is at least in the same realm of credibility as the iceberg theory, physicists notwithstanding. As I understand the theory, our Kansan and Illinoian deposits, plus some others, were left by icebergs floating on a vast glacial marginal lake occupying a crustal depression formed by the weight of the single glacier. We might remark that these deposits form the surficial coprolite (till, lyell) over the southern half of Iowa, the northern half of Missouri, and parts of Indiana and Ohio and a few other states. Then,

1) Where are the beaches? Such a big lake should surely have beaches. Look at Lake Agassiz.

2) Likewise where are the deltas? Likewise big lakes have them, likewise Lake Agassiz.

3) Why were the icebergs so generous, widespread, and uniform in their deposition, or were they immune to wind?

4) If the tops of individual deposited heaps were planed off by wave action, why no sorting or stratification of resulting fill?

5) Or if the clayey gumbotil layers are taken as stratification, how does one explain the lack of carbonates, the high quartz-feldspar ratio, the morphologic similarities to modern soil profiles?

6) Why should the unweathered coprolite (till, lyell) be so hard you can hardly dent it with a spade? According to competent soil engineers such as myself it shows preconsolidation, usually attributed to the weight of the ice. (Actually, of course, it is caused by the violent duodenal contractions of the earthworms.)

7) Where are the aqueous fossils, besides British Columbia?

In this last connection I must admit that the earthworms left no fossils either However, there is a logical explanation for this, and for the multiple deposition.

First we may reasonably conclude that continued eating and recycling of stones would inevitably reduce them in size, as indicated by the strain lines. If we assume that the earthworms selected larger stones and force-fed themselves with their tails, it is not unlikely that as stone diameters decreased, the earthworms inadvertently wrapped all the way around and literally met their ends and eliminated themselves.

Successive waves of earthworms might rediscover the land, but they would have to dig deep and find new stones. In this connection one may note that the European nomenclature for the Wisconsin stage is already divided into Würm I, Würm II, Würm III, and so on. What more can we ask, except that they learn how to spell?

There are other questions I could ask of the iceberg theory, but at the expense of paying attention to my own. I believe I shall now retire and await the arrival of the reporters and photographers. Profile shots only, please; I hate to look so much like Tyrone Power. Ah, science!

R. L. HANDY

Iowa State University of Science and Technology, Ames

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Taxonomy of Research

October 9 was the publication date for *Symposium on Basic Research*, the report of a symposium held last May under the joint auspices of the Alfred P. Sloan Foundation, the National Academy of Sciences, and the AAAS. The very title of the symposium raises the problem of the meaning of the term basic research. Trouble starts when someone asks for a definition, for while one person can define basic research, two are likely to disagree.

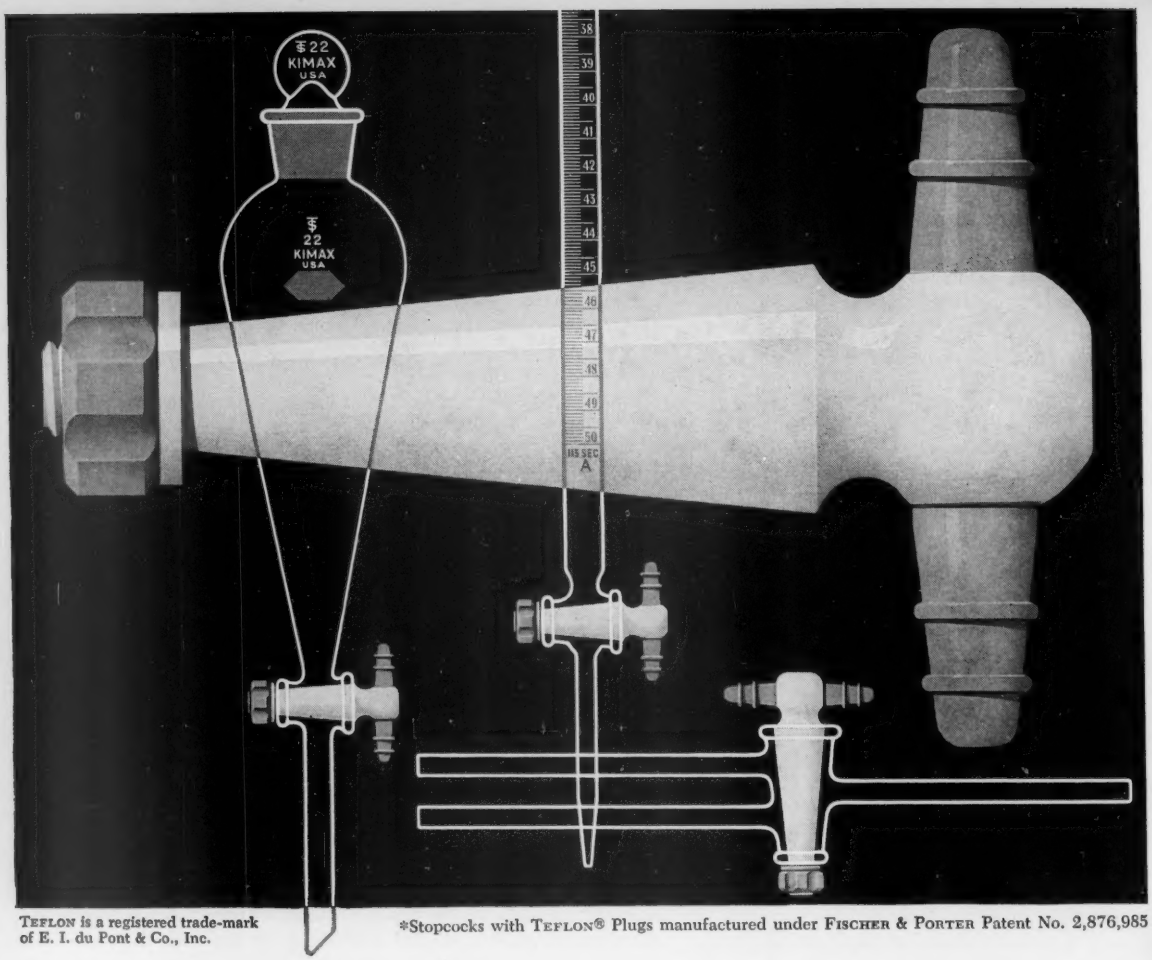
This situation arose at the Symposium on Basic Research. Various definitions were offered; all were objected to. It soon became apparent that it would be very difficult to frame a definition on which all could agree. Some participants thought the effort was worth while and should be made; others took the position that the difficulties were too great. The latter attitude prevailed, and the effort was dropped.

The discussion reminded us of an article in the *Research Review* of the South African Council for Scientific and Industrial Research, and sent us hunting back to the June 1958 issue in which G. M. Dreosti optimistically wrote that "it is high time that definitions be agreed upon among scientists, and officially adopted," and in justification of the need, cited this list of terms: "*academic research, ad hoc research, applied research, basic research, borderline research, developmental research, directed research, experimental research, theoretical research, exploratory research, industrial research, non-directed research, pot-boiling research, pure research, technological research, long-term research, short-term research*," and added that there were many more.

This is a forbidding list if one attempts to distinguish each term from all the others. But the list is useful, for it shows clearly that the terms differ along several dimensions. Perhaps some day an administrative Linneaus will bring taxonomic order into the array. Perhaps a semantic factor analyst will develop a multidimensional classification in which each kind of research fits neatly into its own proper pigeonhole.

Perhaps more likely is the dismal possibility that the word *research* will become useless. H. K. Nason recently wrote in the *Bulletin* of the American Society for Testing Materials, "In words we have discovered a fertile area for application of our national mania of faddism, and already many useful old friends have met the ultimate fate to which faddism always leads—exhausted oblivion. *Research* is the latest discovery of the word hucksters, and already this venerable and useful old term is being sucked dry." There is little protection from the word hucksters, but scientists themselves need not be guilty of using all the variants on Dreosti's list. As C. V. Kidd pointed out in *Science* (13 Feb. 1959) there are two major reasons for distinguishing between basic research and applied research (we can get along without the other terms): In explaining basic research to nonscientists precise definition is not needed to convey "a sense of the nature of basic research, a feeling for its importance, and an appreciation of the motives and working conditions of scientists." In budget classifications so many other factors are involved that common consent or some arbitrariness of definitions must be relied upon, but surely a short list of terms is sufficient.

Instead of futilely trying to define a long list of terms, the better counsel would seem to be to relax about definitions and to concentrate on the quality of the research, regardless of its setting or purpose. This suggestion makes us note that "good research" was not on Dreosti's list. Don't ask us to define that one either.—D.W.



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Current Trends in Linguistics

Though not a predictive science, linguistics has developed effective descriptive and historical methods.

Joseph H. Greenberg

The aim of the present discussion is roughly threefold: to distinguish the characteristic subject matter and methods of linguistic science, to discuss a few of the analytic concepts and substantive results of linguistics which are likely to be of interest to the nonlinguistic scientist, and, finally, to indicate certain recent developments, some of which concern areas of interdisciplinary interest which give promise of ultimate expansion into major subfields either of linguistics itself or of related sciences.

All disciplines are concerned in some fashion or other with linguistic problems. This is so with respect to fields as diverse as the natural and behavioral sciences, mathematics, history, and such humanistic pursuits as the study of literature. This is perhaps most readily evident in the last named instance, since the very data of literature are exclusively linguistic in nature, consisting of a certain body of written, or, in the case of folklore, of unwritten verbal materials. In the social sciences, likewise, there is a body of verbal behavior which is, however, not the exclusive subject matter of these sciences. In law, for example, there are written and unwritten constitutions, statute law, the records of past judicial decisions, and other materials, all of which are presented to the investigator as a corpus of concrete linguistic data. There are likewise the nonverbal acts of the criminal assaulting the victim or the condemned man being led to prison. The meaning analysis of verbal documents is therefore a task of the student of law as well as the relation between verbal and nonverbal acts.

Since only man speaks, the natural scientist does not include verbal behavior among the observational data of his science. This does not mean that the physical scientist does not share with other investigators a certain degree of preoccupation with linguistic matters. In all sciences hypotheses and results of observation can only be stated and communicated by means of a symbolic system, whether by natural language, in this case generally modified in certain respects (for example, through a technical terminology), or whether by a supplementary symbol system whose elements are ultimately defined in terms of natural language. The key role of this linguistic factor leads, in discussion of methodological problems, to an analysis of the language of science itself. Similar considerations obviously apply to the logico-mathematical disciplines and to analytic philosophy in which problems of metalogic and metamathematics are in large measure questions regarding the language of logical and mathematical statements.

Language, then, enters as a factor into all areas of the scientific enterprise. There is, however, one science, linguistics, which, as its very name implies, takes language as its primary object of investigation. Linguistics, however, differs from all other sciences not only in the centrality of its interest in language but also in the manner in which this subject matter is approached. All other sciences, insofar as they are concerned with language, are concerned with the specific content, that is, the meaning, of what is expressed in language, and this in a restricted fashion depending on its subject matter. Linguistics takes as its unique subject matter the structure of linguistic systems as such. Of course, linguistics, like any other science, is also interested in the language of its own subject, for example, problems of the terminology of scientific linguistics. In this aspect it does not differ in principle from any other science which deals with a subject matter other than language.

The two main fields of linguistics as traditionally practiced are descriptive and historical linguistics or, as they are frequently called, synchronic and diachronic. In the former, languages are studied as systems functioning in a single speech community at a single time, and in the latter, under their dynamic aspect of change through time. Although language descriptions are presupposed by historical linguists in that different time states of the same language or different languages which have issued from the same historical source (related languages) can only be compared after they have been described, it was the historical branch under the older name of comparative philology which first emerged as a science, at the turn of the 19th century. It was only in relatively recent times, roughly from 1920 onwards, that the problem of synchronic language description—the nature and requirements of an adequate description of a language—ceased to be taken more or less for granted and became a center of theoretical interest. A number of approaches which first emerged at about this time, and which have been called structural, all have in common an interest in interrelationships within a structure functioning on a single time plane, in contrast with the historical interests which predominated in the 19th century. This development within linguistics is doubtless to be viewed as related to similar contemporary movements in

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neighboring fields, notably Gestalt approaches in psychology and functionalism in cultural anthropology.

The clear separation of synchronic and diachronic aspects is characteristic of linguistics as a science. This is possible because the rate of change in language is slow. Most of us probably have the impression that English has not changed in our own lifetime. On further reflection we will probably recall expressions which have become current in recent periods which did not exist earlier, or items which are no longer in active use. We will not have noticed, for example, the far slower drift in the pronunciation of certain sounds, a realm of linguistic events of which we are far less conscious than the use and meaning of words. As small as the changes in a language appear to be over a single lifetime, the accumulative effect becomes very considerable over a longer period. Thus we have to learn Anglo-Saxon, the form of English as spoken, say in the 11th century, as a foreign language which seems to be roughly as strange as German.

In describing a language for a given time period the linguist makes the assumption that the change in the speech of his informant during this time is negligible so that the system can be studied as an isolate, much as the astronomer studies the solar system as a system, disregarding the gravitational attraction of the stars. The description of a language obviously involves at least two levels, the phonetic and the grammatical. In the former we deal with the organization of the sound into units. In the latter we are concerned with the rules governing sequences of meaningful combinations of such units, for example, words or the smaller meaningful components of words known to the linguist as morphemes.

Phonemic Theory

The basic unit of that part of linguistic description which deals with the sounds of the language is the phoneme, the principle of which is foreshadowed in the prescientific invention of alphabetic writing. The nonlinguist so takes for granted the type of analysis into individual sound units which underlies alphabetic writing that he is unlikely to realize that there is a complex set of theoretic assumptions involved. He tends to believe that alphabetic writing simply renders each different sound by a different letter symbol. In fact, however, there are sound variations of which the naive speaker is generally unaware. For example, the average speaker of English, untrained in phonetics, is unlikely to have ever noticed that the sound spelled *t* in *stop* is unaspirated as compared with the aspirated *t* of *top*. But this difference is sufficient to distinguish separate forms in Chinese, Hindustani, and many other languages. If we approach another language naively we will respond only to those cues which are significant in our own language. On the other hand we will attribute significance to those differences which have a function in our own language whether they have a function in the language we are describing or not. Thus an untrained observer will arrive at essentially the same sound system for any language he describes and two untrained observers with different backgrounds will describe the same foreign language in different ways. Nor will phonetic training in itself overcome this difficulty. The ability to discriminate many sound differences not significant or not even present in one's own language is a necessary but not sufficient condition for success. In the prestructural period of descriptive linguistics the tendency became more and more prevalent, in the name of a naive empiricism, to transcribe phonetically in an attempt to reproduce as accurately as possible the actual sounds, thus producing what, from the point of view of the structure of the language studied, was an ever-growing mass of irrelevant detail. The use of instrumental phonetic apparatus hastened the realization that this type of analysis was a cul-de-sac, for it became apparent from such recordings that in the sound wave itself not even two repetitions of the "same" utterance in the same language are ever physically identical.

A fundamental assumption of linguistic analysis is that a phonetically trained observer will be able to distinguish those differences of sound which are functional in a given language. It seems plausible to assume that any sound distinction employed in a speech community will be fairly gross from the articulatory and perceptual point of view. Along with these distinctions the trained linguist will also note many others which will later turn out to be irrelevant. Since, however, he cannot know a priori which particular features of an utterance will be significant, he must be prepared to indicate them all at the beginning in what is known as a phonetic transcription.

In order to discover which of these sound differences are distinctive in the language investigated, several analytic principles are employed. One of these is that known as complementary distribution. By the distribution of any sound we mean the set of environments in which it occurs. For example in "stop the music!" the environment of the *t* is "s_op the music!" To say that two sounds are in complementary distribution is to say that we have discovered a rule concerning the environments of each which show that these are mutually exclusive. Assuming that the linguist describing English has noted the difference between the aspirated *t* of *top* and the unaspirated *t* of *stop*, further observation leads him to the hypothesis, never contradicted by later observations, that the environments of unaspirated *t* are all characterized by an *s* before the blank and those of aspirated *t* by never having an *s* before the blank. The environments are therefore mutually exclusive and the two sounds are in complementary distribution. Such variant sounds grouped as members of the same phoneme are called allophones.

The principle of complementary distribution is, however, not sufficient, as will be evident from further consideration of the example of aspirated and unaspirated *t*. Since it is also true that *p* (as well as certain other sounds) exhibits a parallel variation, that is, only unaspirated *p* occurs after *s* (as in *spin*, as opposed to the aspirated *p* of *pin*), this unaspirated *p* whose environments all contain an *s* immediately before *p* will likewise be in complementary variation with aspirated *t*. If we rely on complementary distribution alone, we have no way of choosing between unaspirated *p* and unaspirated *t* as the coallophone of aspirated *t*. If we choose both, then unaspirated *p* and unaspirated *t* will become members of the same phone as aspirated *t* and therefore coallophones with each other. But of course they are not in complementary distribution and so cannot by this same rule become allophones of the same phoneme. This example shows that an unconditional rule, stating that two sounds which are in complementary distribution are allophones of the same phoneme, leads to an undesired result. The same allophone will belong simultaneously to different phonemes, so that an unambiguous conversion of allophones to phonemes becomes impossible.

It is clear, then that another factor must be considered, namely, phonetic similarity. We match the unaspirated *p* of *spin* with the aspirated *p* of *pit* rather

than with the *t* of *ten*, although it is in complementary distribution with both. Although in this particular instance the choice is obvious, phonetic similarity is under certain circumstances a vague criterion. Can we always say that a particular sound *a* is more or less similar to two other sounds *b* and *c*?

The solution first arrived at by linguists of the so-called Prague School (*1*), and now quite generally accepted, runs somewhat as follows. Every sound is characterized by a set of simultaneous features, features some or all of which recur in other sounds in other combinations. For example, the English *b* sound has, among other features, that of bilabiality (being formed by articulation of both lips), stop closure, and voicing (vibration of the vocal chords). We then set up the requirement that all the allophones of the same phoneme have a set of features in common which are unique and separate it from every other phoneme. These features constitute, in effect, a definition of the phoneme in question. Features which do not figure in this definition are irrelevant. Thus, aspiration in the case of aspirated and unaspirated *t* is irrelevant but dental articulation is relevant for *t* since it is common to all the allophones and is not found in any of the allophones of *p*, which is bilabial. The example of English /h/ and /ŋ/ (the latter is the phonetic symbol for the final sound spelled *ng* in *sing*) will illustrate the application of this rule. These two sounds are in complementary distribution since /h/ is always syllable initial and /ŋ/ is always syllable final. Instead of saying merely that they are too dissimilar phonetically to be allophones of the same phoneme, we can state that the only phonetic feature common to both is mere consonantality, which is found in many other sounds in English and is not, therefore, unique.

The features of a phoneme may be considered the most elementary units of phonological description. The phonemes of any language may be resolved into combinations of a very limited number of such recurrent features, much smaller than the number of phonemes. Many features clearly involve a correlated pair of mutually incompatible articulations, for example, voicing versus nonvoicing, aspiration versus nonaspiration, and so forth. Jakobson and his associates have striven to reduce all significant features of all languages to 12 such pairs of binary features (*2*). It then becomes possible to derive a measure of relative efficiency of phonemic systems in terms of the utilization of binary features by a simple application of information theory mathematics, since its fundamental unit, the bit, is a single binary choice (*3*, pp. 156–7).

The principles of phonemic theory, though presented here at some length, have been necessarily somewhat simplified. This discussion has been designed to exhibit what is undoubtedly a first-rate achievement of contemporary linguistic science from two points of view: the isolation of a unit which is adequate for purposes of description, and the overcoming, by analytic techniques, of the particular observational bias of the observer, based on his own linguistic background.

Grammatical Theory

It might be maintained that the most significant advance in descriptive grammatical theory has been along similar lines, in the development of methods by means of which the actually functional grammatical categories of each language emerge in the place of a priori classifications derived from the traditional model of Latin grammar as applied to western European languages. More than any other single factor, the work of Boas and his students in the description of American Indian languages exposed the inadequacies of traditional grammatical analyses when applied to languages of very different structure.

The problem of grammatical theory may be most briefly characterized as the problem of generating the theoretical infinity of grammatically possible sentences in a grammar with a finite set of rules. If the number of grammatical sentences in any language were finite then there would be some one or more of these sentences of maximum length, whether reckoned by number of phonemes or by some grammatical unit such as the morpheme or word. But in fact we can always make a given sentence longer by an additional clause beginning with *and*, or in other ways. Although each sentence is of finite length, the number of sentences in any natural language is what is called by mathematicians a countable infinity. But the linguist deals with a necessarily finite corpus of actually recorded sentences. Grammatical theory is therefore necessarily predictive, in a certain sense, in that the rules of the grammar of a particular language enable us to project new grammatical sentences not contained within the corpus. It is likewise only such a theory that will do justice to the ability of the speakers of a language to produce sentences they have never spoken or heard previously and of their hearers to understand such sentences.

An infinitude of grammatically possible sentences can indeed be generated from a finitely large class of meaningful elements (for example, words) if there is limitless possible repetition of members of a particular class, for example, adjectives between the definite article and a noun. Again, the grammar would be vastly complex unless the possibility of combinations of meaningful elements is in terms of such classes whose members all enter into the same or highly similar combinations.

Traditionally grammar has dealt with such classes, or at least the most inclusive ones known as parts of speech, by definitions which involve meaning, as when a verb is defined in terms of activity or a noun as the name of a person, place, or thing. In fact, the inadequacy of such definitions has long been recognized in actual practice. Thus *lightning* is a noun in English, even though it names an activity, and if its nounness is called in question we resort not to meaning but to certain distributional facts, for example, the fact that just like *boy* it can be preceded by the article *the*. Now this means, in effect, that *lightning* is found in the same or similar environments as *boy*, using the term environment in the same sense as earlier in the discussion of phonemic theory, and this, in turn, means that one of the words can be often substituted for the other, as in "The lightning struck the man" and "The boy struck the man." Substitution therefore becomes a key operation in distinguishing grammatically useful classes. It turns out that this technique when applied to different languages will isolate different kinds of classes so that the traditional parts of speech, which do not fit even English very well, must make way for a far more complex typology of kinds of classes of meaningful elements in language.

The recent work of Chomsky (*4*) shows that simple substitution alone, such as described above, is by itself an inadequate, or at least an inconvenient, mechanism for generating the grammatical sentences of a language. A substitution such as that of the above example may be looked upon as a transformation by which, from the sentence "The lighting struck the man," we obtain the new sentence "The boy struck the man." However, it turns out that more com-

Table 1. Consonantal system of an earlier stage of Yiddish.

Mode of articulation	Point of articulation			
	Labial	Dental	Alveo-palatal	Velar
Unvoiced stop	p	t		k
Voiced stop	b	d		g
Unvoiced fricative	f	s	š	x
Voiced fricative	v	z		
Nasal	m	n		ŋ
	Liquids: r, l			

plex transformations are required to account adequately for such relations as that of passive to corresponding active sentences in English. These transformations are applied after the rules of formation of certain basic ("kernel") sentences have been described in a more elementary portion of the grammar ("phrase structure").

The role of meaning in contemporary linguistics has been the subject of much discussion and controversy. It should be emphasized that several quite different questions are involved. The rejection of semantic criteria as defining properties for grammatical classes does not involve necessarily the rejection of meaning itself as a proper subject of study for linguistic science. In fact, it cannot be avoided if linguistic descriptions of specific languages are to have any practical or scientific usefulness. The compilation of dictionaries is a necessary task and clearly falls within the province of linguistics. It is, however, that branch of linguistic description which up to now is the least developed from the theoretical point of view.

Sound Change

The development of structural approaches in synchronic linguistics has had its influence on the more traditional field of diachronic or historical comparative linguistics. Probably the chief effect has been a different manner of viewing change in language. This can be most readily illustrated from the area of changes in sound systems. Earlier descriptions of these changes were generally arranged in terms of each sound through time. For example, a history of the development of the sound system from Latin to modern French would have separate chapters on each vowel and consonant of vulgar Latin, tracing the changes through the course of time. Each sound was thus treated in isolation. The notion of the sounds of a language as a system of interrelated phonemic units leads to the view of change as change of state from one synchronic system to another of later date. Instead, then, of taking the history of the vowel *a* separately through time, we rather ask what was the entire system of sounds of the French language at, say, A.D. 1000, and then at A.D. 1200, and then we view the changes undergone by *a* or any other sound in the context of such systemic change.

The value of such a systematic view as a partial explanatory theory can be illustrated from the following example, which concerns certain changes in the phonemic system of Yiddish. To illustrate the principle involved, it will be sufficient to consider a portion of the consonantal system at a period previous to the changes to be considered. As relevant features in the sense mentioned earlier in our discussion of phonemic systems, we have (i) the contrast of voiced and unvoiced consonants, for example, *b* versus *p;* (ii) that of stop and fricative, for example, *p* versus *f;* (iii) a four-way contrast of point of articulation, for example, labial *p*, dental *t*, alveopalatal *š*, velar *k*; (iv) contrast of nonnasal and nasal, as *p* versus *m*. In addition, there were two liquids, *r* and *l*, which were isolated from the remainder of the consonant systems. The actual combinations of features that made up the relevant portion of the consonantal system can be seen from Table 1.

From the table we can see at least two obvious gaps in this system, representing possibilities for new sounds within the existing framework: a voiced partner for *š*, that is *ž* (as in French *journal*), and a voiced counterpart for *x* (the sound written *ch* in German *Dach*, "roof"). Such a voiced velar fricative would be represented in phonetic notation by γ. The phoneme *ž* came into the system largely through loan words from Slavonic and other languages. The second gap was filled by *r*, formerly a tongue tip trill, which, because of its phonetic structural isolation, was free to shift considerably without merging with any other sound. One variety of the so-called guttural or back *r* with considerable acoustic similarity to the front tongue-tip *r* is precisely γ. In many but not all dialects of Yiddish we then find the sound change $r > \gamma$, by which the formerly isolated *r* shifted backward and abandoned its former structural isolation to fill a gap in the system.

It should be emphasized that other factors beside those of sheer structural arrangement play a role in helping to explain linguistic change even in the case of phonetic change. The work of Martinet (*5*) in this area utilizes as an additional principle that of functional yield. This is the hypothesis that, other things being equal, the contrast between a pair of sounds is more likely to be preserved, the larger the number of different meanings distinguished by them. However, these principles are not sufficient to provide a complete explanation. We cannot, therefore, predict the changes in a linguistic system, although we can limit severely the types of possible changes.

Linguistic Reconstruction

Although linguistics is thus not a predictive science, except in a probabilistic sense, it can in a sense predict backwards in time. By comparing related languages, that is, languages which have developed by independent but regular changes from a single source language, linguists can, by a kind of triangulation known as the comparative method, reconstruct with a high degree of plausibility many features of extinct languages which have left no written records. The scientific status of linguistics is therefore much like that of geology, which can reconstruct but not predict.

In recent years a method has emerged which promises for the first time to furnish an absolute time scale for such reconstructions. This method is known as glottochronology, or lexicostatistics (*6*). If we compare related languages, we see that certain elements of vocabulary which stand for common items of human experience are extremely stable, in that they are not easily replaced by borrowed words from a foreign language, and are likely to persist over very long periods. Such are terms for low numerals, parts of the human body, water, fire, and so forth. The more closely languages are related, the more of such cognate (that is, related) items they will still have in common. For example, English will have more of these basic terms in common with German than with the more remotely related French. We assume that in a standard list of, say, 100 such items, replacement by new terms is random over time. Then if the proportion of retained items in some arbitrary fixed period of time, *t*, is some constant, *C*, which is to be determined,

then in the next period of equal length the same proportion of the remaining items will be retained so that for $2t$ the amount of survival from the original list is C^2, or, in general, $nt = C^n$. If we compare two related languages, rather than one language at two different times, we assume that the changes in the list for the two languages is independent and at this same rate. The value of the constant itself has been established empirically by considering languages for which there are written records over a considerable time span and noting the proportion of basic words which survive during this interval. The most recent determination of this constant on the basis of a standard list of 100 words is .864 ± .065 per millennium at the 5-percent confidence level. This means that a language retains approximately 86.5 percent of these 100 words over a period of 1000 years. By the use of this constant we can calculate the probable date of separation of two languages with a certain proportion of resemblance r in the list of 100 as t millennia by use of the formula

$$t = \log C / 2 \log r$$

where C is .864 as mentioned above. Although there are still difficulties to be overcome in the use of this method, it has already been applied to problems of prehistory with some success (*7*).

Other More Recent Developments

The topics already discussed all fall squarely within linguistics proper. A few of the more recent developments which concern somewhat peripheral areas, or which are chiefly of interdisciplinary interest, may be mentioned. One such topic is that of the application of statistical methods to the study of language. As has been seen, the standard model of grammatical description is nonquantitative. Its rules are adequate insofar as they allow us to decide whether a novel sequence is or is not grammatical. This is a yes-or-no decision which does not take into account the frequency of the sentence itself or of constituent elements, phonetic or grammatical, actually found in the use of the language by its speakers. The study of the properties of such frequencies by the use of samples of texts was largely pioneered by Zipf (*8*), who treated such problems as the proportional frequency of words as a function of their rank order of frequency within texts of given length. The most recent developments in this field have been along the general lines foreshadowed by Zipf.

The study of the acoustics of speech sounds, which may be considered a border area between linguistics and physics, with important bearings on the phonetic aspect of linguistics, has made important advances in the last decade or so, largely through the invention of the sound spectrograph, which permits a very exact study of the physical characteristics of the sound wave (*9*). The most important single result has probably been the discovery that the acoustic difference between vowel sounds depends fundamentally on the reinforcement of two basic frequency regions, called the first (lower) and second (higher) formants. These formants vary rather directly with two of the chief articulatory characteristics of vowels. The higher the tongue position, the lower the first formant, and the farther front the raising of the tongue the higher the second formant. Thus the high front vowel *i* has the lowest first formant and the highest second formant. The subsequent invention of a speech synthesizer, by which sounds are produced by means of hand-painted spectrograms as inputs, allows the manipulation of features of the sound wave, which is then judged perceptually by subjects so that the cues for the perception of speech sounds can be systematically studied. This line of experimentation has already produced interesting and significant results. It has been discovered, for example, that a basic cue for distinguishing one stop consonant from another is the transition to or from the formants of the vowel which follows or precedes respectively (*10*).

In the relatively unexplored area between linguistics and cultural anthropology known as ethnolinguistics, and that between linguistics and psychology known as psycholinguistics, the sharpest issues have been raised through the largely posthumous interest in the writings of Benjamin Whorf (*11*).

The Whorfian thesis, or linguistic Weltanschauung hypothesis, as it has been called, stated in extreme form, would be that the general manner in which the speakers of a language conceive the world is determined, or at least influenced, by the grammatical categories of their language. This manner of conceiving includes, in a global manner, culturally shared cognitive structures, value systems, and such psychological processes as individual perception, degree and accuracy of recall, choice of alternative principles of classification in matching experiments, and so forth. When stated in such over-all terms, the theory obviously suffers somewhat from vagueness. The Committee on Linguistics and Psychology of the Social Science Research Council has sponsored an extensive program in interdisciplinary research—involving linguists, psychologists, and anthropologists—among monolingual and multilingual speakers of Hopi, Navaho, Zuñi, Spanish, and English in the southwestern part of the United States. This project, which began in 1954, is known as the Southwest Project in Comparative Psycholinguistics. The basic design of the studies undertaken has been to obtain data by employing the same psycholinguistic experiments on speakers of different languages and on bilinguals with varying degrees of knowledge of the two languages they speak. In such studies the speaker's language is designed to be the only independent variable. As yet, only partial results have been published. An examination of these data and the unpublished reports of the project leads to the conclusion that agreement in fundamentals of human linguistic behavior far outweighs the idiosyncratic differences to be expected on the basis of the relativity hypothesis.

Finally, something should be said concerning the academic organization of linguistic science and some of its practical applications. Scientists whose chief field of specialization is linguistics are actually found in a variety of departments, including those devoted to specific foreign languages, English, speech, and anthropology. Several major universities have separate linguistics departments (for example, Columbia, California, and Pennsylvania), but even here linguists will be found in other departments. This disparity of departmental affiliations is largely overcome by the existence of linguistics clubs in all of the larger and many of the smaller universities, and by the existence of a general professional organization, the Linguistic Society of America, and of both general and specialized journals.

Linguistic science has made major contributions to the teaching of English as a foreign language, to the teaching of foreign, particularly exotic, languages to Americans, to the devising of orthographies, and to the problems of machine translation of languages. Such applications are bound to increase with the continuous widening of American inter-

est in remote portions of the world and the corresponding need for specialist training in the local languages. The present status of linguistics as a science is on the whole an encouraging one. Aided, no doubt, by a subject matter of transparently systematic type, it has been able to develop sophisticated and effective methods of descriptive analysis and historical reconstruction which give it a unique place among the sciences concerned with human behavior (*12*).

Reference

1. N. Trubetskoy, "Grundzuege der phonologie," *Trav. Cerc. Linguistique Prague*, 7 (1939).
2. R. Jakobson, C. G. M. Fant, M. Halle, *Preliminaries to Speech Analysis* (Acoustics Laboratory, Massachusetts Institute of Technology, Cambridge, 1955).
3. C. Osgood and T. A. Sebeok, Eds., *Psycholinguistics* (Waverly, Baltimore, Md., 1954).
4. N. Chomsky, *Syntactic Structures* (Moulton, 's Gravenhage, Netherlands, 1957).
5. A. Martinet, *Economie des changements phonétiques* (Francke, Berne, 1955).
6. S. C. Gudschinsky, *Word* **12**, 175 (1956); M. Swadesh, *Intern. J. Am. Linguistics* **21**, 121 (1955).
7. A. L. Kroeber, *Intern. J. Am. Linguistics* **29**, 113 (1955).
8. G. K. Zipf, *Human Behavior and the Principle of Least Effort* (Addison-Wesley. Cambridge, Mass., 1949).
9. R. K. Potter, G. A. Kopp, H. C. Green, *Visible Speech* (Van Nostrand, New York, 1947).
10. P. C. Delattre, A. M. Liberman, F. S. Cooper, *J. Acoust. Soc. Am.* **27**, 769 (1955).
11. J. B. Carroll, Ed., *Language, Thought and Reality: Selected Writings of Benjamin Lee Whorf* (Wiley, New York, 1956).
12. Other works of possible interest to the reader are: J. H. Greenberg, *Essays in Linguistics* (Univ. of Chicago, Chicago, Ill., 1957); C. F. Hockett, *A Course in Modern Linguistics* (Macmillan, New York, 1958); H. Hoijer, Ed., *Language in Culture* (Univ. of Chicago, Chicago, Ill., 1954).

Evolution of Enzymes and the Photosynthetic Apparatus

Primitive photochemistry and porphyrin catalysis after separate genesis join in modern photosynthesis.

Melvin Calvin

The basic idea of evolution can be applied to prebiological times as well as to the transformations that occurred after living organisms appeared on the earth. In order for biological types of processes to have functioned, it is clearly necessary that an independent mechanism be developed for the production of organic material on the surface of the earth by methods which do not depend on living things as we now know them.

A number of such methods are chemically conceivable and, in fact, some of them have actually been tried out experimentally (*1*, *2*). Ultraviolet radiation, for example, was one of the earliest (*3*). Thermal energy was also among the early sources considered as a possible means of generating organic material (*3*). The first application of thermal sources involved the generation of heavy metal carbides and their hydrolysis to produce unsaturated hydrocarbons such as ethylene and acetylene (*3*). These latter substances could then undergo a variety of reactions, including polymerization, to produce large organic molecules.

More recently (*4*), a thermal step has been introduced at a later stage in the development of organic material, after the primary development of such molecules as the simple amino acids and keto acids, through the agency of ionizing radiation. This ionizing radiation might have been of several types —electrical discharge, cosmic radiation entering from outer space, or radioactivity on the earth itself. All three of these types of ionizing radiation have since been experimentally demonstrated to be capable of producing the kinds of molecules that were needed to begin the process of chemical evolution.

If one adds to this the recognition that the fundamental character of the important catalysts (enzymes) of present-day living organisms is the result of the evolutionary development of rudimentary catalytic powers present in the simple ions or molecules of the inorganic, or prebiological, environment, all the elements necessary for the ultimate appearance of living organisms are available to us.

Development of Rudimentary Catalysts

Even the most cursory examination of what is now known about the nature of present-day enzymatic mechanisms cannot fail to impress one with the apparent identity in kind between the enzymatic reactions and the reactions as they are known to the organic chemist in the laboratory. For example, glyoxalase, by which methyl glyoxal is converted to lactic acid, is nothing more or less than an internal Cannizarro reaction that is catalyzed by bases. Almost all of the hydrolytic reactions—those of esterase, proteases, phosphatases — have their nonenzymatic counterparts in the form of generalized acid or base catalysis, or more specialized catalysis by metal salts. For example, again in the case of the phosphatases, the freshly precipitated trivalent metal hydroxides are extremely effective, or manganese ion is effective as a rudimentary phosphotransferase (*5*).

One particular group of catalysts which is widely dispersed in present-day biological systems is that centered around the element iron—particularly catalase, peroxidase, and cytochrome. Here, a rather quantitative comparison can be made between the ability of the bare iron atom to perform some catalytic function and the ability of the iron atom to perform the same catalytic function as it has been developed in biological systems. Thus, in Fig. 1 one sees a comparison of the hydrated iron ion, the iron ion surrounded by a por-

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phyrin as it is in heme, and the iron ion porphyrin, or heme, as it is incorporated into a protein, surrounded by two or more coordinating groups of the protein to form catalase. The progressive increase in catalytic ability is from 10^{-5} for the aqueous ferric ion to 10^{-2} for the heme, to 10^{5} for the complete enzyme.

These are definitions of the catalytic function of the iron for the reaction involving the decomposition of hydrogen peroxide. However, we know that the iron has many other functions as well, most of which involve oxidation or reduction. For example, even catalase itself can function as a peroxidase, using hydrogen peroxide to oxidize organic substrates, provided the hydrogen peroxide is sufficiently dilute. Undoubtedly the iron is also involved in what we now recognize as oxidative phosphorylation—that is, the conversion of the energy liberated upon the passage of an electron from a highly reducing potential to an oxidizing agent, such as oxygen or other material, with the concomitant storage of some of that energy in the form of unstable (pyrophosphate) linkages which may be later used for other purposes.

In order to convert the rudimentary catalytic functions which must exist in all the elements and their simple compounds into the highly efficient ones that we now recognize as enzymes, we must introduce two additional ideas, one from the realm of chemistry and the other from the realm of genetics, both of which, however, could be considered manifestations of exactly the same phenomena. The first of these, from the realm of chemistry, is the idea of autocatalysis—that is, the basic notion that the product of a reaction may itself be a catalyst for the conversion of precursors into itself (*6*). This is a very common phenomenon in chemistry and perhaps is best illustrated in one of the simplest cases—namely, the reaction of molecular hydrogen with cupric ion. This reaction leads, thermodynamically, to the formation of cuprous ion and oxidized hydrogen, either as acid or water, depending upon the anion with which the cupric ion is associated. It so happens that the reaction of molecular hydrogen with cupric ion, although thermodynamically possible, is extremely slow without catalysis. However, the product of this reaction—that is, cuprous ion—is an extremely good catalyst for the reaction

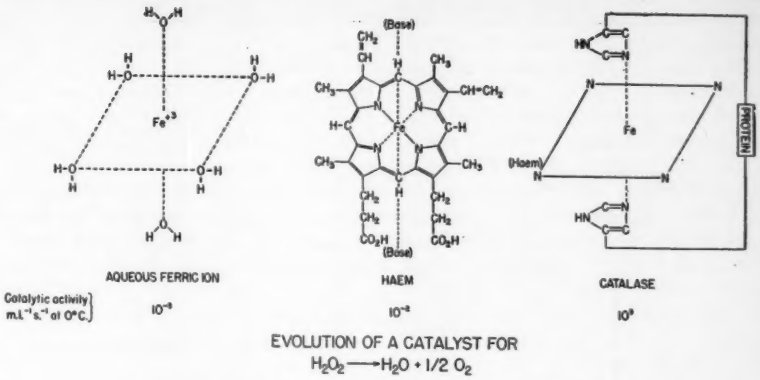


Fig. 1. Evolution of a catalyst for hydrogen peroxide.

between hydrogen and cupric ion. Therefore, one can imagine (and indeed we realized this experimentally long ago) (*7*) a system consisting of molecular hydrogen and cupric ion which would remain in this form for a long period of time. However, should either a very slow noncatalytic reduction lead to cuprous ion, or some random electron transfer lead to the formation of an appreciable number of cuprous ions in the mixture, then immediately the entire reaction mixture would go over to the more stable system. Thus, we can provide a basis for chemical selection for the development of prebiotic evolution, leading to progressively more complex and specific organic structures.

Synthetic Sequences

The other notion that I would like to introduce is the one developed by the geneticist Horowitz (*8*) as a basis for biochemical selection after the appearance of mutable organisms. He suggested that the very complex sequences that we are now finding to be responsible for the synthesis of most of our existing biological material could have developed in a backward manner, beginning with the completely heterotrophic organisms. He postulated that the first organisms, the first living things, were complete heterotrophs and had available to them all possible precursors for their own duplication, and that their only function was to bring these together to produce themselves. One can then visualize a process in which at first one essential constituent of the mixture is depleted. Then, the particular organizational unit that has found a way to manufacture the depleted item from remaining molecules will, of course, survive, whereas those units which are unable to do so will disappear, since they can no longer reproduce themselves. Such a process of gradual depletion of available substrates, with the evolution of continually longer and longer chains of synthesis, would then constitute the origin of the synthetic sequences that we are now finding in present-day living organisms.

Enzymes

With these two ideas we can see how an enzyme, or, I should say, a highly efficient catalyst, could be built. It is perhaps worth while to trace such a development in a specific instance with which we might be familiar: for example, the iron porphyrin. Fortunately, the essential steps in the present-day biosynthetic route to porphyrin have been unraveled for us (*9*). One could begin with succinic acid and glycine, two compounds which we already know can be made by the various random methods mentioned above, such as gaseous discharge or ionizing radiation or ultraviolet light (*2, 4*). From these (succinic acid and glycine) an alpha-amino-beta-keto acid is formed, followed by decarboxylation to delta-aminolevulinic acid; two of these molecules then condense to form a pyrrole nucleus, porphobilinogen. This molecule then passes through a series of steps, involving a number of oxidations, leading finally to protoporphyrin (*9*). The skeleton of this is shown in Fig. 2.

With the introduction of iron into the protoporphyrin—or perhaps a bet-

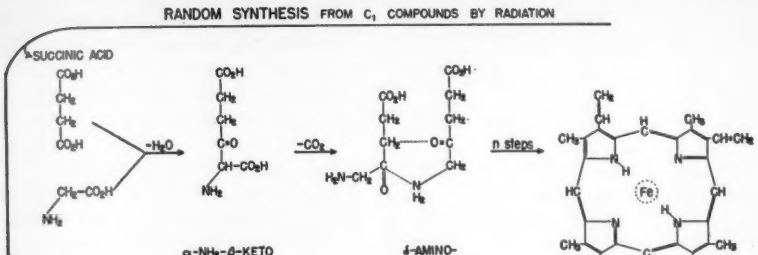


Fig. 2. Possible catalytic function of iron in a modern biosynthetic sequence (from succinic acid and glycine).

ter way to view it would be, with the surrounding of the iron by the protoporphyrin grouping—the iron becomes a better oxidation catalyst, and, as is shown in Fig. 2, there are several oxidation steps along the biosynthetic route as we now know it. Thus, one has only to suppose that one or more of the sequences of steps leading to protoporphyrin is dependent upon an iron-catalyzed oxidation (and this is almost certainly so) to arrive at the conclusion that once such an iron protoporphyrin is manufactured it will itself accelerate its own synthesis from such precursors as succinic acid and glycine, and thus will tend to build up the supply of the material and improve the iron catalyst that will be available for a variety of other functions as well. As yet, a nonenzymatic (modern biological catalyst) synthesis of this general type has not been described, but it appears that very few attempts have been made.

Development of the Photosynthetic Apparatus: Carbon Reduction

I shall review briefly what our present state of knowledge appears to be with respect to the existing mechanism by which the photosynthetic apparatus in the green plant and in the lower organisms can convert electromagnetic energy into chemical potential as reduced carbon and molecular oxygen. One need hardly do more than point out the essential features of the process to recognize its present-day separation into several distinct parts (*10*). The reduction of carbon dioxide, we now have every reason to suppose, occurs in a series of reactions which can take place entirely in the dark. In fact, all the enzyme systems that we now know participate in the conversion of CO_2 to carbohydrates have been found in a wide variety of organisms, many of which are not photosynthetic. For example, the *Thiobacillus* (*11*) contains very nearly all the necessary enzymes, and *Escherichia coli* (*12*) grown in xylose contains not only carboxydismutase but also a number of other enzymes involved in the carbon-reduction cycle. The final step was indeed taken when Racker (*13*) was able to make a mixture of all the requisite enzymes and the energy-storing compounds (reduced triphosphopyridine nucleotide and adenosine triphosphate) which produced hexose phosphate from carbon dioxide, all in the dark.

We can therefore follow van Niel (*14*) and reaffirm the suggestion that the photochemical apparatus in the green plants is primarily concerned with the splitting of the water molecule and the generation of reducing agent and intermediate oxidant. The latter (intermediate oxidant) will eventually find its way into molecular oxygen. The former (reducing agent) will be used to reduce the compounds formed by combination of carbon dioxide with suitable intermediates in the cell. From our knowledge of the nature of the carbon cycle (*10*) it is already clear that adenosine triphosphate is also required for this latter process, and this adenosine triphosphate may be generated either by oxidative phosphorylation or by a recombination of the intermediate oxidant with some intermediate reductant that has been formed by direct photolysis. Thus, we can suppose that the reaction sequence that is now used by green plants for the reduction of carbon dioxide was developed independently of the photosynthetic apparatus, and was presumably later coupled to the energy-capturing and -transforming mechanism which the photosynthetic apparatus represents.

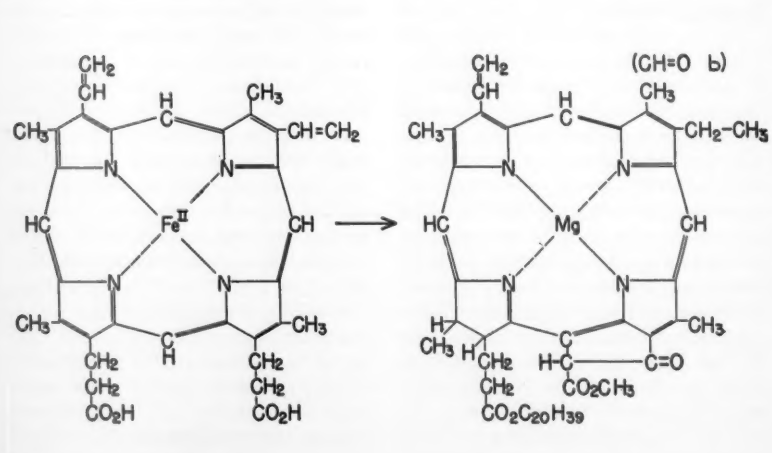


Fig. 3. Structural relationships between heme and chlorophyll-a.

Photon Conversion

We must now examine the nature of the photochemical apparatus to see if we can discover something of its origin. The primary energy-trapping molecule is, of course, a porphyrin, chlorophyll. In recent years, the work of Granick (*15*) has clearly indicated, if not conclusively demonstrated, that present-day synthesis of chlorophyll is a branch in the synthetic sequence leading also to the hemes. This branch seems to occur just before the insertion of the iron into the phorphyrin ring (Fig. 3).

We can thus see that the most likely course for the evolution of the photosynthetic apparatus involved the prior existence of the porphyrin type of catalytic structure. This catalytic structure was evolved not in response to the existence of sunlight but, rather, in response to the other evolutionary driving force which we have already seen operative in the development of the porphyrin nucleus—namely, the oxidative catalysis at which iron compounds of the porphyrins are so efficient. This leads to the suggestion that either the development of the porphyrin was not directly dependent upon the existence of oxygen in the primordial atmosphere and occurred in response to its function in other oxidative dismutations not involving molecular oxygen or that there was molecular oxygen in the earth's atmosphere prior to the advent of the photosynthetic apparatus producing it now.

The development of such highly organized structures as are now found in the organelles of the cells, such as the chloroplasts and mitochondria (*16*), seems to me to be incompatible with the degree of penetration of the ultraviolet radiation from the sun in the wavelength around 2500 angstroms, which would have occurred had there been no oxygen in the atmosphere. Today, of course, the oxygen in the upper atmosphere is photodissociated by this very ultraviolet light and is thus converted into quantities of ozone, which, in turn, strongly absorbs in the region between 2200 and 3000 angstroms. While it is possible to conceive of the development of heterotrophic organisms in the shelter of deep water, and thus not exposed to the destructive ultraviolet, it is difficult to conceive of the evolution of a photosynthetic apparatus, even a primitive one, also in the same environment, since there would be little visible light available, either, for the selective mechanism.

Thus, we are constrained to believe that not only was the evolution of higher organisms delayed until appreciable amounts of oxygen appeared in the atmosphere but that the evolution of the porphyrin catalysis itself, and of some of the more complex structural elements of living cells, also had to await this protection. Presumably, it came about by virtue of the photodissociation of water into hydrogen and oxygen, followed by the escape of the hydrogen from the gravitational field of the earth and the leaving behind of an appreciable quantity of oxygen, even though it is now entirely photosynthetic in origin. We can thus envisage the development of the highly organized structural units which we see today, in the form of mitochondria prior to the development of the chloroplasts and the photochemical apparatus. The similarity in the structure of these two organelles is very striking, and it is not unreasonable to suppose that the latter had its origin in the former (Fig. 4).

Coupling

Thus, the porphyrin molecule and the structural unit into which it is built had an independent evolution. Only at a much later time did the coupling of the optical properties of the porphyrin molecule to the energy demands of the carbon-reduction cycle take place. This presumably occurred at a time when there may already have been a rudimentary photosynthetic energy-yielding apparatus in the near ultraviolet, perhaps using sulfur compounds as direct absorbers. The more efficient light-energy-capturing molecule, such as porphyrin, could not be used in energy conversion until it was divested of the iron atom which was its principal reason for being. A reason for this is the requirement for a long-lived excitation after the capture of the quantum. The iron porphyrin, although absorbing a good deal of visible light, cannot have a very long-lived excitation because of the presence of the magnetic iron atom in the molecule. The inhomogeneous magnetic field surrounding the iron atom breaks down the selection prohibitions and does not allow long-lived excitation of porphyrin. However, if the iron is replaced by magnesium, or some other diamagnetic divalent cation such as zinc, then these molecules can have long-lived excitations which are essential for energy migration and conversion with any high degree of efficiency.

The rudimentary beginnings of a chlorophyll type of photosynthesis may have occurred in the precellular period, in a period that had already seen the appearance of lipid-type coacervates (*3*) and in which the disc-like molecules of chlorophyll could assume a pseudocrystalline arrangement facilitating energy transport and conversion (*17*). In all probability, it was at this point (or very near this point) that the cellular habitat of life took shape. Finally, the generation of the oxygen-evolving mechanism, perhaps requiring the participation of the carotenoids and other such materials, occurred, leading to development of the higher plants (*18*).

As is the case with the precursor forms in biotic chains of evolution, it is not likely that we will discover on earth any of the rudimentary prebiotic systems of which we have spoken (*19*). However, the time is fast approaching when it will be possible to explore at least three nonterrestrial environments —those of the Moon, Venus, and Mars. The possibility of finding materials in an evolutionary stage which might correspond to the early stages of terrestrial evolution is real and finite (*20*). It is,

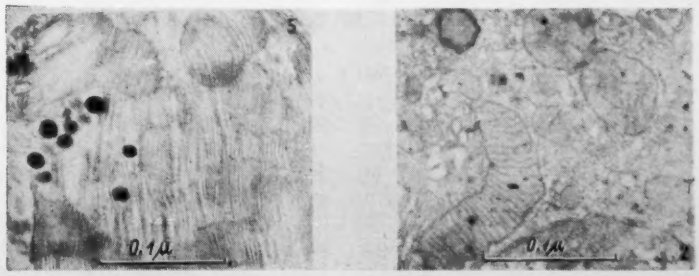


Fig. 4. Comparison of structure of mitochondria and chloroplasts. [After Sjöstrand]

therefore, of the utmost importance to avoid any action which will, by terrestrial contamination, forever jeopardize, or even destroy, the possibility of distinguishing organisms or prebiotic chemical forms which might be discovered, particularly on Mars.

Suitable methods of close-in spectroscopic investigation and upper atmosphere sampling should be developed and used so as to make knowledge available prior to any direct contact, and it is to be hoped that any vehicles which are at all likely to make contact with these surfaces will be biologically sterile and as chemically and biochemically clean as it is possible to make them (*21*).

References and Notes

1. W. M. Garrison, D. C. Morrison, J. G. Hamilton, A. A. Benson, M. Calvin, *Science* **114**, 416 (1951).
2. S. L. Miller, *J. Am. Chem. Soc.* **77**, 2351 (1955).
3. A. I. Oparin, *The Origin of Life* (Oliver and Boyd, London, 3rd English ed., 1957).
4. S. W. Fox, K. Harada, A. Vegotsky, *Experientia* **15**, 81 (1959).
5. J. M. Lowenstein, *Biochem. J.* **65**, 40P (1957); *Biochim. et Biophys. Acta* **28**, 206 (1958).
6. M. Calvin, *Am. Scientist* **44**, 248 (1956).
7. ——— and W. K. Wilmarth, *J. Am. Chem. Soc.* **78**, 1301 (1956); J. Halpern, *Quart. Revs. (London)* **10**, 463 (1956).
8. N. Horowitz, *Proc. Natl. Acad. Sci. U.S.* **31**, 153 (1945).
9. D. Shemin, *Harvey Lectures Ser.* **50**, 258 (1956).
10. M. Calvin, *J. Chem. Soc.* **1956**, 1895; also, *Radiation Biology and Medicine*, W. D. Claus, Ed. (Addison-Wesley, Reading, Mass., 1958), chap. 31.
11. P. A. Trudinger, *Biochem. J.* **64**, 274 (1956); G. Milhaud, J. P. Aubert, J. Millet, *Compt. rend.* **243**, 102 (1956).
12. R. C. Fuller and M. Gibbs, *Plant Physiol.* **31**, xxxi (Aug. 1956).
13. E. Racker, *Nature* **175**, 249 (1955).
14. A. J. Kluyver and C. B. van Niel, *The Microbe's Contribution to Biology* (Harvard Univ. Press, Cambridge, Mass., 1956), chap. 6.
15. S. Granick, *Harvey Lectures Ser.* **44**, 220 (1950).
16. F. Sjöstrand, *Umschau* **4**, 751 (1954); E. Steinmann and F. Sjöstrand, *Exptl. Cell Research* **8**, 15 (1955).
17. M. Calvin, "Brookhaven Conference on Biology, No. 11, 1958," *Brookhaven Natl. Lab. No. 512 (C-28)* (1959), p. 160; *Rev. Modern Phys.* **31**, 147, 157 (1959).
18. U. Blass, J. M. Anderson, M. Calvin, *Plant Physiol.*, **34**, 329 (1959).
19. M. Calvin, *Evolution*, in press.
20. J. Lederberg and D. B. Cowie, *Science* **127**, 1473 (1958).

21. Preparation of this paper was sponsored by the United States Atomic Energy Commission.

Science in the News

Building for Unique Science High School Dedicated in the Bronx

A new building for New York's Bronx High School of Science was dedicated on 27 October. The dedication focuses deserved attention on this unique institution, which provided secondary education for more than 1 in 200 of all persons who received their doctorates in the United States during 1957. Most of the doctoral degrees that have been earned by Bronx High alumni were in the pure sciences and in engineering, according to a study that is being conducted by Samuel Strauss of McKinley High School, Washington, D.C., for the Office of Scientific Personnel, National Academy of Sciences—National Research Council.

An earlier study, made in 1952, determined that approximately 80 percent of the school's graduates are associated with science, mathematics, or science-related professions, and that many alumni are now occupying important posts in universities, scientific and engineering institutions, and private and government laboratories. This record has been achieved in a relatively short span of time, for the school is only 21 years old.

History

The Bronx High School of Science is a school for the gifted. It was established in 1938 by the Board of Education of the City of New York as a public academic high school for boys with a particular interest and ability in science and mathematics. In 1946 the school was opened to girls, who have since that time been admitted in the ratio of one girl to every two boys. The current population of the school is approximately 1800 boys and 900 girls.

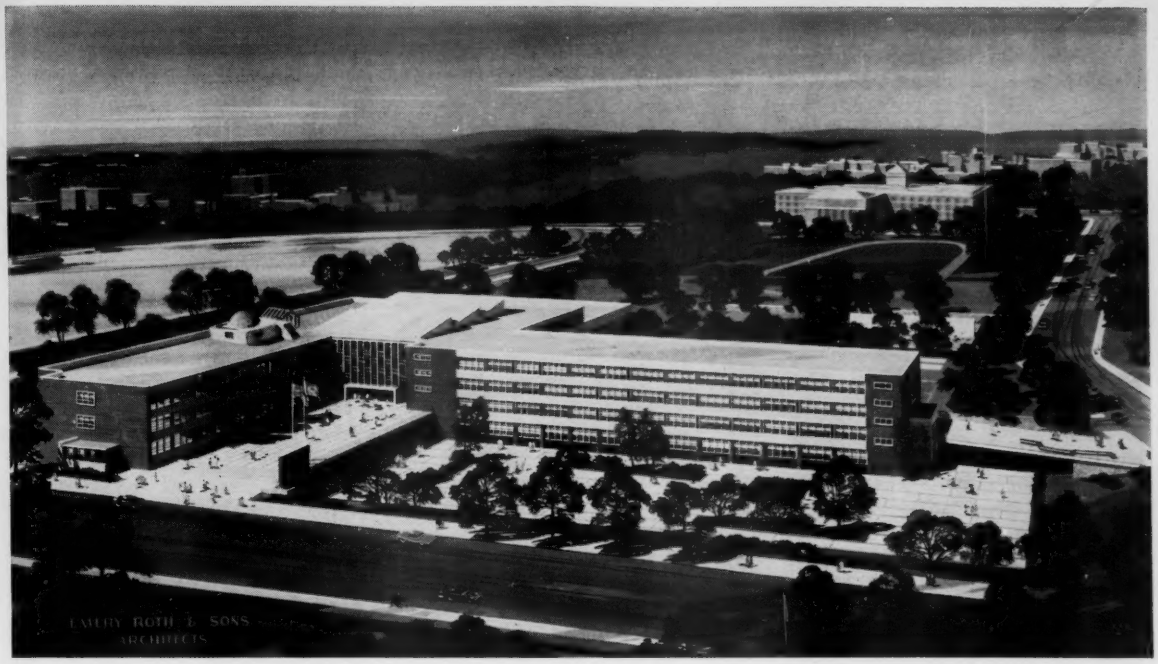
For its first 20 years, the school was headed by Morris Meister, whose portrait hangs in the entrance of the building that was dedicated on Tuesday. Last year Meister resigned to assume the presidency of the newly founded Bronx Community College. He was succeeded as principal by Alexander Taffel, former head of Haaren High School in New York City and a physicist who studied under Isidor I. Rabi and the late Enrico Fermi.

Curriculum and Academic Performance

The students at the Bronx school are selected from applicants from every part of the city of New York on the basis of an entrance examination, as well as on previous scholastic record and achievement. The effect of the selection process is to produce an entering class with a median IQ of 140, achievement in reading and arithmetic about 2 years beyond chronological age, and an aptitude for science and mathematics. The school is harder to get into than many colleges; in 1957, 3900 of New York's superior students applied, and only 750 were accepted.

The curriculum consists of a basic core of required courses, supplemented by a number of elective courses in the areas of the pupil's special interest. Required courses for 4 years at Bronx High are as follows: 3 years of mathematics (most students take more); 5 years of the sciences; 4 years of English; 4 years of social studies; 1 year of mechanical drawing; ½ year of science laboratory techniques; at least 3 years of Latin, Spanish, French, German, or Hebrew; and music, art, and health education. For outstanding students, there are special courses in English, mathematics, physics, biology, and chemistry that lead to college admission with advanced standing.

The achievements of the students in scholarship competitions have been consistently outstanding. At the present time the school holds top place in the nation in the winning of awards in



The new building for the Bronx High School of Science that was dedicated on 27 October.

the Science Talent Search of the Westinghouse Educational Foundation. During the 18 years that this contest has been in existence, the school has provided 21 winners. In the National Merit Scholarship contest, Bronx students have this year won 51 semifinalist positions, more than the number won by any other high school in the United States. The June graduating class of some 750 students earned about 500 scholarships.

Despite the high scholastic achievement, students have the normal sports and extracurricular interests of young people their age. In sports they are at present the New York City champions in tennis, and they make a strong showing in swimming.

It is hardly necessary to mention that the school has a highly competent faculty that is thoroughly trained in subject matter as well as in educational methodology. Many members of the staff are authors of textbooks and professional articles, and there are among them an unusually large number of Ph.D.'s. Last year Taffel told *Time:*

"We do a better job than comprehensive schools do in their honors courses. The teacher is the key; in our school the teacher doesn't have his courses divided so that he has to spend time with slower pupils. He's free to try new things. He can stimulate and become as stimulated as his students; if he's wise, he grows with them."

Time also quoted a teacher as having commented: "It's a privilege to be here; it's constantly exhilarating. The problem is that so many of the kids are brighter than we are. We know darned well our IQ's don't match most of theirs." Another faculty member is reported to have observed: "When you get a bright youngster and focus his interest early, the kid soars like a comet. He gets a five- to ten-year start in professional life."

Unusual Facilities Available

In addition to the usual facilities that one would expect in a high school, the new building has the following special facilities: six elementary and six advanced laboratories in biology, chemistry, and physics; a mathematics laboratory; ten shops and drafting rooms; three photography laboratories; two greenhouses; a planetarium; a radio station; a weather station; an animal room; a home technology laboratory; and four student-project laboratories.

In the accompanying illustration, the dome of the planetarium is visible on the roof of the building. It will be provided with a Spitz projector and will be used to demonstrate certain aspects of astronomy that are taught in connection with some of the advanced physics and advanced mathematics courses.

Special Activities Program Launched

The four project laboratories and the two greenhouses are being used in connection with the creative activities program in science that has recently been established at the school. The purpose of this program is to provide opportunities for highly motivated students to carry out research projects.

At present five research classes are organized in the fields of biology, chemistry, and physics. A teacher supervises the work of some 15 to 25 students in each project laboratory. Typical research projects were carried out during the past year in the following areas: identification of blood types in frogs, absorption of radio phosphorous by *Paramecium*, effect of gibberellin on acquatic plants, effect of ultra-violet light on the mutation rate in *Drosophila*, design of a digital computer, analysis by chromatography, design of Newtonian reflecting telescope with astro-camera, and analysis by electrophoresis.

This work is augmented by a summer-institute program in which—with

support from the National Science Foundation and several private foundations—students are placed in research laboratories throughout the New York and the New England areas, where they gain valuable experience as apprentices.

Conference Spurs Nuclear Energy and Basic Sciences in Pan American Union

At its first meeting last week, the Inter-American Nuclear Energy Commission set the framework for the future activities of South and Central American states in the use of nuclear energy and, more broadly, in the role of science. Representatives of 15 nations took part in the 5-day organizational meeting in Washington which, by means of 11 resolutions, charted the future development of the commission. The resolutions, in addition to establishing the working practices of the group, call for cooperative programs for training, education, and research in the nuclear sciences and for dissemination of information on nuclear energy in Latin America. They also call for a survey of the use of radioisotopes in research in the Americas, symposia on the peaceful applications of nuclear energy, and the elimination of tariff barriers on materials used in scientific training and research.

The commission is an outgrowth of a proposal made by President Eisenhower at a meeting of the presidents of the American states in July 1956. At that time he suggested that the field of atomic energy represented one possible avenue toward closer cooperation among the American republics. At a later meeting, this proposal was given specific form when Dr. Milton Eisenhower suggested the creation of the Inter-American Nuclear Energy Commission. After some delay, the commission was formed as a semiautonomous organization with its own secretariat and with strong ties to the Organization of American States. The relationship, according to a spokesman, is very similar to that between the United Nations and its many specialized agencies.

Basic Science Needs Stressed

Although most of the Central and South American nations are eager to put atomic energy to work as soon as possible, there is general realization, which was evident at the Washington meeting, that the immediate major need is for a cadre of scientific and engineering personnel to train and direct others, in both the national and international programs. Toward this end, the members of the commission considered two possibilities. The first, a single large center for training, education, and research in the nuclear sciences for all of Latin America, was rejected on the grounds that it would be inefficient. "A better alternative," one of the resolution papers states, "appears to be the increased utilization of existing national facilities and the encouragement of worthwhile new endeavors in the various fields of nuclear specialization on a regional, rather than purely national, basis." A resolution to study the latter plan was among the 11 adopted by the commission. Such a cooperative program, the commission directed, should give priority to the following subjects, in the order given: mathematics for nuclear science; basic physics and nuclear physics; nuclear engineering and technology; use of isotopes in scientific research, agriculture, medicine, and industry; health and safety in the use of nuclear materials; and geology and mining of nuclear materials.

The priority list reflects the general view among the delegates that nuclear studies cannot be pursued *in vacuo*, and that a general advancement in all the sciences underlies progress in the nuclear sciences. On this point, J. D. Perkinson, executive secretary of the commission and a former member of the training and education division of this country's Atomic Energy Commission, said: "The secretariat of IANEC and the delegates were consistently concerned during the sessions with the importance of the basic sciences as a foundation for any nuclear program." The other side of the coin, as the secretary pointed out, is that "it is well established that the institution of a national nuclear program has frequently stimulated the improvement of basic science and research."

U.S. Sees Health Gain

At the meeting, which was attended by leading scientists and atomic energy officials of Latin American countries, the United States' delegate, John J. Floberg of the AEC, said that atomic energy, chiefly through the use of radioisotopes, can be expected to make great contributions in the field of health. Work in which radioisotopes are used to study human parasites has been under way for some years under the direction of Marcel Roche, who attended the Washington meeting as president of the Venezuelan delegation.

Because it is expected the commission will develop relationships with other international groups dealing with atomic energy, the meeting was attended by a number of representatives of these organizations, including Sterling Cole of the International Atomic Energy Agency. Others attending as observers were members of the National Academy of Sciences, the United Nations Food and Agricultural Organization, and the Pan American Health Organization.

In addition to representatives of the U.S. and Venezuela, the meeting was attended by representatives of the following countries: Argentina, Bolivia, Brazil, Colombia, Cuba, the Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Peru, and Uruguay.

As the last of its resolutions, the commission set 22 August 1960 as the date for its second meeting, to be held at the Pan American Union in Washington, D.C.

In one of the last addresses at the conference, Roche, who was elected vice chairman for the coming year, summarized the work done.

"The general working plan for the coming year has been drafted. The seat of the next Inter-American symposium and the topic of discussion has been selected. Valuable inter-American contacts for cooperation in future atomic energy programs have been established, and in some cases more detailed preliminary agreements have been reached. A working group has been established for the purpose of drafting a coordinated and complete plan for training, education, and research in nuclear sciences in America. The importance of the work of this group cannot be over-emphasized. We all know—and in the present meeting this has been repeatedly stated—that education in all fields is the first need of our Latin America, and that all our efforts are doomed to failure if we do not take vigorous steps to increase our technical capacity and to augment the number of men trained in science in our countries."

President Transfers Elements of Army Rocket Center to Space Agency

President Eisenhower decided last week to transfer all of the Army's space activities to the National Aeronautics and Space Administration. The action, if approved by Congress, will put Wernher von Braun's team of scientists and engineers at the Army Ballistic Missile Agency in Huntsville, Ala., under civilian control and will remove the Army from the nation's space exploration program. The move, widely anticipated by observers, came as the result of a meeting last week of the President with officials of the Department of Defense, NASA, the Bureau of the Budget, and his science adviser.

In recent weeks, officials of the Eisenhower administration have issued many public statements on the current position of the government on the issue of space activities and military preparedness; these statements, which were very similar in nature, represent the argument behind the President's decision. The argument, in brief, is this: the United States now has adequate rocketry to meet its military needs; the development of high-thrust rockets, such as the Saturn project of the Army agency, would be superfluous to these needs; therefore, such projects, which are of value only for the exploration of space, should properly be under the agency which has responsibility for this activity, the civilian space agency. As the President put it during a press conference: ". . . [the] great booster is of no present use to the Defense Department. Its interest is in NASA, and that's the reason that we have decided to take this very competent team of scientists, and this facility, the ABMA and put it into the space department so that it can get the kind of booster that it wants."

Comment on the executive action by the individuals concerned, members of Congress, and the press, was generally favorable. Von Braun said in Huntsville that he looked forward to continuing efforts in a progressive program under the National Aeronautics and Space Administration. The retiring head of the Army agency, General John B. Medaris, commented that he was "both pleased and relieved" that a definitive decision has been made. The day after the President's decision, General Medaris began conferences with T. Keith Glennan, administrator of NASA, to develop a plan for submission to Congress for the orderly transfer of control of the Army agency which, according to Glennan, will not be moved from the Huntsville site.

Approval of the action also came from Senator Lyndon Johnson (D-Texas), chairman of the Special Senate Committee on Space and Astronautics. It was "gratifying," the Senator said, "that the need for action has been recognized. But further action appears to be necessary." Saying that the nation's space program seems to lack "coordinated authority" and "a driver," he ordered a preliminary Congressional inquiry.

The inquiry might have a significant impact because Congress, by law, has veto power over the transfer of any military space activity to NASA. The view generally expressed in Washington is that, after careful study, the House and Senate will approve the transfer.

Out of the President's press conference following his decision came heartening news for the space agency which has suffered from uncertain financing. In reply to a question, the President said that the administration would ask for more funds for NASA for the next fiscal year. "Something more than we had last year," he said. The Administration's last budget estimate for NASA was $530 million, but Congress cut this figure by about $30 million. At the time of the cut Glennan warned that it would have severe effects on this country's showing in space activities.

University Participation in International Affairs To Be Studied

An independent national committee has been formed to study the participation of American universities in international education, research, and technical assistance. The new group, known as the Committee on the University and World Affairs, consists of nine leaders from universities, government, business, and foundations. Its chairman is J. L. Morrill, president of the University of Minnesota.

The committee has the strong interest and encouragement of the Secretary of State. His representative, Robert H. Thayer, Special Assistant to the Secretary for the Coordination of International Educational and Cultural Relations, was instrumental in bringing about establishment of the new group.

Report Scheduled for 1960

The committee, in a report that it expects to issue in 1960, will recommend ways in which the traditional concept of the American university can be adapted, in principle and in practice, to present-day relations of the United States with other nations. In the course of preparing its report, the committee will examine the educational and research work of universities related to international affairs, the role of the universities in assisting foreign countries to develop educational and research institutions and the cooperation of universities in government technical-assistance programs and in programs for the exchange of students and faculty.

The Ford Foundation has appropriated funds for the committee's research, operating, and publication expenses. The group will be independent of the foundation, however, and its recommendations will be entirely its own.

In addition to Morrill, the members of the committee are as follows: Harold Boeschenstein, president, Owens-Corning Fiberglas Corporation; Harvie Branscomb, chancellor, Vanderbilt University; Arthur S. Flemming, Secretary of Health, Education, and Welfare; Senator J. W. Fulbright, chairman of the Senate Foreign Relations Committee; John W. Gardner, president, Carnegie Corporation of New York; Franklin D. Murphy, chancellor, University of Kansas; Philip D. Reed, chairman of the Finance Committee, General Electric Company; and Dean Rusk, president, Rockefeller Foundation. Ralph J. Bunche, under secretary for special political affairs of the United Nations will serve as consultant.

Since World War II, American universities have expanded their international interests. According to statistics compiled by the Institute of International Education, 47,245 students from 131 foreign countries were studying on American campuses in 1958–59. In addition, 1937 foreign professors, lecturers, and research scholars were on the faculties of 288 American institutions. On the other hand, 1842 faculty members from 367 American colleges and universities were in teaching, research, or consultive assignments in 82 foreign countries.

The new committee's primary objective will be to make policy recommendations to both universities and the government for more effective participation by American educational institutions in international affairs.

AAAS–Westinghouse Science Writers Contest Draws 166 Entries

Science writers whose work appears in American newspapers and magazines have submitted 166 articles for the AAAS - Westinghouse Science Writing Awards competition. A prize of $1000 for the best article appearing in each type of publication will be awarded at the annual AAAS meeting in Chicago this December.

Of the entries submitted, 102 were articles that appeared in magazines between 1 October 1958 and 30 September 1959, the time span for the contest, and 64 were newspaper stories. Some participants submitted multiple entries.

A committee composed of Hillier Kriegbaum, department of journalism, New York University; Sidney Negus, department of biochemistry, Medical College of Virginia; and James Stokley, school of journalism, Michigan State University will screen the entries. Seven judges will choose the two prize-winning articles from those selected by the committee. In addition to the $1000 prizes, citations will be awarded to the newspaper and magazine in which the articles appeared. At the discretion of the judges, special citations also may be awarded for distinguished service in science journalism.

The judges are: Graham DuShane, editor of *Science*; Earl English, dean of the school of journalism at the University of Missouri; Caryl Haskins, president of the Carnegie Institution of Washington; James A. Linen, publisher of *Time*; Morris Meister, president of Bronx Community College; Alan T. Waterman, director of the National Science Foundation; and J. Russell Wiggins, vice president and executive editor, *Washington Post and Times Herald*, and president of the American Society of Newspaper Editors.

"Century 21" Postponed until 1962

The international Century 21 Exposition, originally scheduled to open in Seattle, Wash., in May 1961, will open instead in April 1962. This world fair will emphasize science and its relationship to the development of man. On 9 September Congress allocated $9 million for federal participation, the largest amount ever appropriated for an international exposition in the United States. On the following day Century 21 launched a study to examine the exposition's time schedule as it related to building and exhibit design and construction, and to the equally important matter of obtaining significant participation from U.S. industry, foreign governments, and other potential exhibitors.

The 3-week study was completed by 1 October, after correspondence and conferences with representatives of foreign governments, U.S. industry, the National Science Planning Board, the U.S. Department of Commerce, the General Services Administration, and others who have a role in organizing the exposition. On the basis of the report of the study, the exposition officers and steering committee have recommended the later opening date. Concurrence in this action has been obtained from the U.S. Department of Commerce; Frölich Rainey and members of the National Science Planning Board; the General Services Administration; Allen Beach, deputy director of the exposition; and various interested U.S. industries.

The Department of Commerce has appointed an architect to plan the federal science pavilion and is beginning work on the comprehensive exhibit-design program made possible by the Congressional appropriation.

The General Services Administration will direct the design and construction of the federal science pavilion.

Beach met recently in Washington with representatives of foreign embassies. In July these embassies received their first formal invitations from the U.S. State Department. Beach's report showed that most foreign governments that are now expressing interest in becoming exhibitors are convinced they will need additional time to obtain exhibit funds from their legislative bodies.

Various U.S. industries have been awaiting federal action which would determine whether Century 21 is to be an international exposition or merely a regional fair. Representatives of these industries point out that their 1960 budgets are now being completed. If their exhibits are to be of international-exposition caliber, special appropriations from their boards will be necessary.

Physician-Population Ratio Declining

The Public Health Service reports that the ratio of physicians to population in the United States, which has ranged between 131 and 135 per 100,000 persons for 20 years, will drop to 126 per 100,000 by 1975 unless the rate of graduating students increases substantially. The number of dentists per 100,000 persons in the population will decline even more sharply. These predictions are provided by a recent PHS publication, *Health Manpower Source Book, Section 9: Physicians, Dentists, Nurses*, which describes trends in the education, location, and specialization in the professions named.

In the academic year 1958–59, the 85 medical schools in the United States graduated 6895 physicians. To maintain the present physician-population ratio, U.S. medical schools would need to graduate about 10,360 students by 1975 — nearly 3000 above the 7410 graduates currently predicted for that year.

The 47 dental schools in the United States graduated 3083 dentists in the academic year 1957–58. Despite the addition of eight new dental schools since World War II and large increases in the number of graduates, the ratio of dentists to population remains below pre-World War II levels. This decline is expected to continue. To regain the current dentist-population ratio, about 2700 more dental graduates above the number currently predicted will be needed in 1975. This requires a 75-precent increase in the number of dental students who, according to present estimates, will be graduated during that year.

According to the report, the ratio of dentists was 62 per 100,000 people in 1940, 57 in 1958, and is expected to decline to about 50 per 100,000 in 1975.

Belvedere Fund Established

Belvedere Scientific Fund has been established in San Francisco to support activities and provide grants in the fields of natural science. Present interest is centering upon Baja California, Mexico. Scientific director of the fund is Ira L. Wiggins, who is on leave from Stanford University.

The fund, in cooperation with the California Academy of Sciences, began investigations of the natural history of Baja California in the autumn of 1958. Two extended overland expeditions and

several brief reconnaissance trips have already been completed, and additional exploratory work is under way. The initial project will place primary emphasis on botanical research in that area, but it is expected that future projects will be undertaken in other disciplines and in other areas.

Under a grant from the fund, it is expected that the California Academy of Sciences will substantially expand its present library on all phases of the natural history and resources of Baja California. Donations to, exchanges with, or information about items that might be added to this library will be welcome. Correspondence about such items and inquiries about the research program should be addressed to: Belvedere Scientific Fund, 155 Sansome St., San Francisco 4, Calif.

National Observatory Announces Visiting Scientist Programs

The National Radio Astronomy Observatory was established by the National Science Foundation to make available to scientists from any institution facilities for research in radio astronomy. The observatory now has in operation a radio telescope of 85-foot diameter, together with receivers for work at various wave-lengths in the range 75 to 3.75 cm. The facilities of the observatory are open to any competent scientist with a program of work in radio astronomy, regardless of institutional affiliation.

A scientist who wishes to undertake work at the observatory should apply by letter to the Director, National Radio Astronomy Observatory, P.O. Box 2, Green Bank, W. Va. The letter should contain a description of the program to be carried out, including a statement of the objects to be investigated and their positions, expected flux densities or antenna temperatures, the receivers to be used, any additional or special equipment that will be needed, and the investigator's estimate of the time required for the program.

The observatory also invites inquiries, from any scientist interested in radio astronomy, concerning the opportunities and facilities available. No previous experience in the techniques of radio astronomy is necessary.

The National Radio Astronomy Observatory is operated by the Associated Universities, Inc., under contract with the National Science Foundation.

Grants, Fellowships, and Awards

Fertility. The Lalor Foundation has announced its 1960 program of awards for research in the biological sciences. These awards will be for support of research on the fundamental biochemical and physiological mechanisms concerned with fertility and reproduction in various forms of life. The objectives are to further the knowledge and understanding of the basic phenomena involved and to extend and develop the possibilities for effective regulation and control.

The awards may range up to $8000 per year, depending upon the scope and duration of the projects approved. Preference will be given to younger members of university and college staffs, with an upper age limit of 45 years. Proposed work may be carried on at the applicant's own institution or elsewhere.

The foundation will also grant postdoctoral summer or short-term research awards at the Marine Biological Laboratory at Woods Hole, Mass., or elsewhere, for appropriate projects in the fields specified. For these awards, the stipends will ordinarily not exceed $900 for a single man or woman, $1100 for a married man working at his home institution, and $1250 for a married man with principal program at another institution.

Requests for information and for application forms should be directed to the Lalor Foundation, 4400 Lancaster Pike, Wilmington 5, Del. The final date for receipt of executed application forms, complete with supporting data, is *15 January 1960*. Notification of appointment will be on or before *15 March*. The 1960 program follows closely the pattern of the current 1959 program, under which 27 awards were granted.

Pharmacognosy. The American Foundation for Pharmaceutical Education has announced the Edwin Leigh Newcomb Memorial Awards in Pharmacognosy. Published papers may be submitted, but they must represent work published not more than 1 year prior to its receipt by the awards committee. For information, write to Dr. H. W. Youngken, Massachusetts College of Pharmacy, 179 Longwood Ave., Boston 15, Mass.

Teaching equipment. The National Science Foundation has announced that *31 December* is the deadline to apply for awards under its program to encourage mathematicians, scientists, and engineers to devise new laboratory equipment for school and college courses. The objective of the program is to aid competent scientists to develop new equipment of potentially wide usefulness. Grantees are expected to supply teachers with full information about apparatus they devise. Such information is commonly distributed in the form of reports, articles in professional journals, and presentations at professional meetings. Once equipment has been developed, grantees are expected, as well, to permit interested commercial suppliers to enter negotiations for production and marketing. Further information may be obtained from the Course Content Improvement Section, National Science Foundation, Washington 25, D.C.

Women. The American Association of University Women has prepared a list of its graduate fellowships and international grants for 1960–61. This may be obtained from the Committee on Fellowships Awards, American Association of University Women, 1634 I St. NW, Washington 6, D.C. The application deadline for most of the awards is *1 December*.

News Briefs

The reactor for this country's first full-scale, privately financed nuclear power station has sustained its first chain reaction, according to a joint announcement by the General Electric Company and the Commonwealth Edison Company. Criticality was reached at the Commonwealth Edison Dresden nuclear power station 50 miles southwest of Chicago after engineers placed the 28th fuel element in the reactor core. When completely loaded, the core will contain 488 such elements. General Electric designed and built Dresden for the Commonwealth Edison Company and the cosponsoring Nuclear Power Group, Inc., which has seven members in addition to Commonwealth Edison.

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A national tabulation of malformations at birth will be started in 1960 by the Office of Vital Statistics. The program resulted largely from the wide interest in the hereditary effect of radioactivity.

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Fellowships in the Arts and Sciences 1960–61, edited by Virginia B. Potter, was published on 5 October by the Association of American Colleges. This is the third annual edition of this direc-

tory of fellowships offered by government, foundations, industry, and other sources outside of universities. Copies of the book may be obtained at $3.75 from the Publications Division of the American Council on Education, 1785 Massachusetts Ave., NW, Washington 6, D.C.

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A set of final examinations given at the Russian 10-year school was included in testimony on Soviet education presented by Vice Admiral Hyman Rickover to the House Appropriations Committee at hearings last August. Recently the printed transcript containing the examinations was made available. Normal circulation for such a record is 1000 copies; however, within 10 days the committee had received requests for more than 5000 copies.

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An exchange program between the Czechoslovak Academy of Sciences and the Waldemar Medical Research Foundation is now in progress. Three scientists from the Czechoslovak Academy will pursue their researches at the foundation's Port Washington, N.Y., laboratories during the 1959–60 period, and in 1960–61 representatives of the Waldemar laboratory will conduct studies in Czechoslovakia. These studies are concerned with problems of tumor immunity, immunotherapy, and the pathophysiology of the host-tumor relationship.

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Funds for the performance of research and development in private industrial firms totaled $7.2 billion in 1957, according to a National Science Foundation report, *Funds for Research and Development Performance in American Industry, 1957.* Of this amount, more than half was accounted for by two industries: the aircraft industry and the electrical equipment industry. Total performance of research and development in private firms increased about one-fifth between the 2 years covered, 1956 and 1957, from $6 billion to $7.2 billion. The survey also showed that during 1957 $3.7 billion, or slightly more than one-half of the total research and development performed by private industrial firms, was financed by the Federal Government.

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Massachusetts General Hospital, Boston, has received a gift of $1 million from the Joseph P. Kennedy, Jr. Memorial Foundation for the establishment of the Joseph P. Kennedy, Jr. Laboratories for Research on Mental Retardation. Half of the amount will be spent for the construction of the laboratories and the other half will serve as an endowment to provide continuing operating funds. The new research unit will be concerned with the causes, treatment, and prevention of diseases of the brain occurring during infancy and childhood. The work will be directed by Raymond D. Adams, the hospital's chief of neurology and Bullard professor of neuropathology, Harvard Medical School.

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A monograph entitled "The Analysis of Fatty Acid Mixtures by Gas-Liquid Chromatography: Construction and Operation of an Ionization Chamber Instrument," by John W. Farquhar *et al.* of the Rockefeller Institute, was published as a separate supplement to the August issue of *Nutrition Reviews.* Reprints of this 30-page, illustrated pamphlet are available, free, from the publisher of *Nutrition Reviews,* the Nutrition Foundation, Inc., 99 Park Ave., New York 16, N.Y.

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A United States exhibit describing the historical development and use of high-speed computers in information processing has begun a tour of French universities and other European educational centers. The exhibit, "Progress in Information Processing," was prepared by the National Science Foundation in cooperation with other government agencies and with industrial groups. The tour is sponsored by the U.S. Information Services. Showings also have been arranged at meetings and institutions in the United States.

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A "Summary-Analysis" of hearings on industrial radioactive waste disposal was released recently by the Joint Congressional Committee on Atomic Energy. The publication reviews the major points developed during hearings held during January, February, and July 1959, by the Special Subcommittee on Radiation, under the Chairmanship of Representative Chet Holifield (D-Calif.).

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According to Peking radio, scientists in mainland China have discovered a well-preserved lower jaw of a Peking woman, a human being who lived half a million years ago. The jaw was excavated by a team from the Institute of Vertebrate Paleontology of the Chinese Academy of Sciences in a cave at Choukowtien, outside of Peiping, where the first fossils of Peking man were found in 1929.

Scientists in the News

Hans A. Bethe, theoretical physicist, who in 1938 developed the theory that the carbon-nitrogen cycle is instrumental in the sun's energy production, has been named recipient of the Franklin Medal, highest award of the Franklin Institute. Bethe, who is the John Wendell Anderson Professor of Physics at Cornell University, received the medal at formal institute ceremonies on 21 October.

Wallace R. Brode, science adviser to the Department of State, was named president-elect of the Optical Society of America at its 44th annual meeting. He will succeed **James G. Baker,** consultant to the Harvard University Observatory, who is president of the society for 1960.

Armin C. J. Braun has been appointed a member and professor of the Rockefeller Institute. Braun, a plant physiologist, has been at the Institute since 1938. Among other honors, he has received the Newcomb Cleveland prize of the AAAS, which was presented at the 1949 Annual Meeting.

John P. Conrad, professor of agronomy at the University of California, Davis, retired 1 October after 38 years of service. In 1947, Conrad was chosen Faculty Research Lecturer at Davis in honor of his work on soils and crop-yield relationships. His studies have included effects of crop residues on yields of following crops and basic work on soil enzymes.

Conrad expects to leave this month for a 2-year assignment in Panama City, where he will be curriculum adviser to a new College of Agriculture at the University of Panama.

The following individuals have received the Special 1959 Albert Lasker Awards for Extraordinary Public Service to the nation's health: **Senator Lister Hill** (Alabama), chairman of the Senate Committee on Labor–Health, Education, and Welfare Appropriations; **Representative John E. Fogarty** (Rhode Island), chairman of the House Sub-Committee on Labor–Health, Education, and Welfare Appropriations; **Maurice Pate,** executive director, United Nations Children's Fund, New York; **John Holmes Dingle,** Western Reserve University Medical School, Cleveland; **Albert Coons,** Harvard University Medical School, Cambridge;

Jules Freund, National Institutes of Health, Bethesda, Md.; **Gilbert Dalldorf,** The National Foundation, New York, and formerly head of research laboratories, State Department of Health, Albany, N.Y.

The Franklin Institute has awarded the Frank P. Brown Medal posthumously to **Hardy Cross,** a former Yale professor, whose original moment distribution method revolutionized the design procedures for reinforced-concrete structures. The medal citation to Cross, who died in February of this year, reads: "For his outstanding career as a teacher, especially of engineering students during the past fifty years at Hampden-Sydney College, Brown University, the University of Illinois, and Yale University; for his many contributions to professional publications during this time; and finally for his original and later supplementary papers on the moment distribution method of analyzing indeterminate structures."

Navy Distinguished Public Service awards were recently made to **Lawrence Gould,** president of Carlton College, Northfield, Minn.; **Herbert Wexler** of the United States Weather Bureau; and **Hugh Odishaw** of the National Academy of Sciences. The awards were given to the three civilian scientists for their direction of International Geophysical Year programs.

Vincent dePaul Goubeau, vice president and director of materials of the Radio Corporation of America, recently received the Howard Coonley Medal of the American Standards Association. **William L. Barth,** retired head of the engineering standards section of General Motors Corporation and executive secretary of the standards committee, received the association's Standards Medal. The two gold medals were presented at an award dinner 21 October in conjunction with the Tenth National Conference on Standards.

Arthur Chovnick, assistant director of the biological laboratory of the Long Island Biological Association of Cold Spring Harbor, has been appointed director. He will succeed **M. Demerec** upon the latter's retirement on 1 July 1960.

C. William Besserer and **Floyd E. Nixon** have joined Prentice-Hall, Inc. as coeditors of the Space Technology Series.

Louis G. Henyey has been appointed director of the Leuschner Observatory and chairman of the department of astronomy at the University of California, Berkeley. He succeeds **Otto Struve,** who has taken a leave of absence from the University to serve as director of the National Radio Astronomy Laboratory at Green Bank, W. Va.

John F. Morse has been appointed chief of the student-loan program under the National Defense Education Act. Morse, who will be on leave as vice president of Rensselaer Polytechnic Institute, in Troy, N.Y., succeeds **Peter P. Muirhead,** now director of the financial aid branch of the Office of Education's Division of Higher Education.

Sylvan Wallach, assistant project manager with Gibbs and Cox, Inc., has been named manager of the theoretical department of Associated Nucleonics, Inc., a subsidiary of Stone and Webster Engineering Corporation. He will be responsible for reactor physics, shielding, hazards analyses, and related work performed as part of the company's consulting services in the nuclear field.

The 1958 Wien Award for oustanding contributions to the science of cancer cytology will be presented to **John R. Heller** at a citation dinner to be held 7 November. The award is made annually to the scientist whose work or projects represent "outstanding research in cancer cytology." The award consists of $1000 cash and a bronze plaque.

Loren Eisely, anthropologist, resigned 16 October as chairman of the department of anthropology at the University of Pennsylvania, to become provost of the university. He will continue as a professor in the department.

The following scientists will receive awards at the 41st National Metal Exposition and Congress of the American Society for Metals, to be held 2–6 November in Chicago.

Rene Perrin, president and board chairman of Ugine Steelworks, France, will receive the Albert Sauveur Award.

John L. Atwood, president of the North American Aviation, Inc., will receive the ASM Medal for the Advancement of Research.

Matthew A. Hunter, dean emeritus of Rensselaer Polytechnic Institute, will receive the 1959 Gold Medal of the ASM.

Recent Deaths

Fred W. Borden, San Francisco, Calif.; 65; inventor of the standard x-ray stereoscope, a device for three-dimensional viewing of x-rays, and the Borden Hemorrometer, an instrument for continuous measurement of blood lost during surgery; 24 Sept.

Wheeler P. Davey, University Park, Pa.; 73; retired research professor of physics and chemistry at Pennsylvania State College; author of *A Study of Crystal Structure*; 12 Oct.

Nathan L. Drake, Riverdale, Md.; 60; University of Maryland professor of chemistry and chairman of the department; 13 Oct.

Harry D. Kitson, Mishawaka, Ind.; 73; retired professor of psychology, Teachers College, Columbia University, and a specialist in vocational guidance; author of *How to Use Your Mind*; 25 Sept.

Paul Kosok, New York; 63; archeologist and former chairman of the department of history and government at Long Island University; author of *Land, Water,* and *Life in Ancient Peru*; 4 Oct.

Benno E. Lisher, St. Louis, Mo.; 83; dean emeritus of the Washington University School of Dentistry; 9 Oct.

Julian D. Loudon, Toronto, Canada; 78; retired chief physician at St. Michael's Hospital and author of many medical papers; 16 Oct.

Bela Mittelmann, New York; 60; psychoanalyst and research psychiatrist; visiting professor at the Albert Einstein College of Medicine; 4 Oct.

Julia E. Moody, Natick, Mass.; 90; professor emeritus of zoology at Wellesley College; 16 Oct.

Gottfried Neumann, New York, N.Y.; 58; assistant professor of gynecology and obstetrics at New York University–Bellevue Medical Center, and chief of the Sterility Clinic at Bellevue Medical Center; 26 Sept.

Frederick H. Paulson, Warwick, R.I.; 61; former director of the American Society of Civil Engineers; 29 Sept.

Frank P. Shepard Jr., Greenwich, Conn.; 39; assistant professor of pathology at Columbia University; 14 Oct.

Paul Welch, Ann Arbor, Mich.; 77; professor emeritus of zoology at the University of Michigan; noted researcher in entomology and limnology; author of a textbook *Limnology*; 1 Oct.

O. B. Williams, Austin, Texas; 64; chairman of the department of bacteriology at the University of Texas; 23 Sept.

Book Reviews

The Child, the Parent, and the State. James Bryant Conant. Harvard University Press, Cambridge, Mass., 1959. 211 pp. $3.50.

James Bryant Conant holds a unique position in American education. He is the only contemporary American of international renown as a scientist, university president, and statesman who has chosen, over the years, to devote a major portion of his energies to the improvement of education at the pre-university level. Other scientists and scholars have expressed surprise at this diversion of his energies and doubt that a study of the American high-school provides the best use of the talents of a man of Conant's stature. But these doubters reveal an ignorance of history and a failure to recognize what is most important in determining the course of America's future. Conant's choice would not have seemed strange or irrelevant to such men as Jefferson and Franklin, for they also accepted it as a responsibility of statesmen and men-of-affairs to think long and deeply about the problems of educating free men and to make vigorous recommendations for improving the people's schools. When the history of 20th-century America is written, it may well be that Conant's contribution to secondary education will be given equal place with his contributions to other fields.

Already his influence is enormous. All across the land school boards, citizens' committees, and groups of teachers and educational leaders are discussing the Conant report, *The American High School Today*, which appeared last winter, and in many schools his recommendations are being put into practice this fall.

This, in itself, is an interesting commentary on the state of American education. It seems clear that the American people have grown weary of the endless debate over the schools, the sharply critical attacks, and the querulous replies that the critics are unfair or don't know what they are talking about. The people know that something is wrong; now they want to be told what to do about it, but they do not trust either the educators or their critics to tell them. They do trust Conant, a man of unquestioned integrity, enormous prestige, and considerable educational experience, who has no axes to grind.

In *The Child, the Parent, and the State*, which may be considered a supplement to the report that became a best-seller last spring, he repeats his pleas for the elimination of small high-schools, for better guidance, for four years of foreign language for those who take any at all, and for ability-grouping with special programs for the academically talented within the framework of the comprehensive high-school. But the present book goes more deeply into the problems of secondary education both here and abroad and examines these problems in their historical perspective.

Conant's account of the revolutionary transformation of the American high-school between 1905 and 1930 is informed and perceptive. He gives attention to the social forces that caused the change, as well as to some of the individuals who played a part in fostering it. He discusses the secondary schools of England, Prussia, France, and Russia, the governmental framework within which the schools in these countries operate, and the effect of these schools on the national character. Khrushchev's "Memorandum on school reorganization" (September, 1958) and the Soviet "Law on school organization" are included in the appendixes.

Although he does not underestimate European education, Conant sees in the public comprehensive high-school a distinctly American institution, uniquely suited to our needs and purposes, and he concludes that it would be unwise, and probably impossible, for us to adopt any European pattern. Adoption of such a pattern would require drastic changes in the laws that govern employment of juveniles and the age of leaving school, the establishment of a national examination system for selecting students for the various secondary schools, and the abolishment of the liberal arts college, which is not found in Europe, where students go directly from secondary school to the university. "Anyone who wishes to take on seriously a reform movement to bring about any one of the changes I have listed is welcome to the job. To my mind he wouldn't get to first base, nor should he."

In discussing European education, Conant draws upon his own extensive experience abroad. In discussing American schools, he speaks from the background of personal visits to more than 50 high-schools in all parts of the country and the reports of his able staff on many others.

Conant relies heavily upon these observations and defends the empirical approach, while expressing a distrust of the deductive method of thinking about educational problems. "When someone writes or says that what we need today in the United States is to decide first what we mean by the word 'education,' a sense of distasteful weariness overtakes me. I feel as though I were starting to see a badly scratched film of a poor movie for the second or third time. In such a mood, I am ready to define education as what goes on in the schools and colleges, and I am more inclined to examine the past and present practices of teachers than to attempt to deduce pedagogical precepts from a set of premises."

This operational definition of education will delight many educators, but in it lies a danger. It is quite true that it is risky for the scholar in his ivory tower to try to deduce educational principles and recommend practices without going out to observe schools and children. But it is equally dangerous for the practical man to draw conclusions on the basis of observations alone, without first doing some hard thinking about the nature of the good life, the aims and purposes of education, and the proper limitations of the school's responsibility.

If he were innocent of basic principles and deductive logic, a man might observe schools for many years and still conclude that cheer-leading is just as important as mathematics. Conant makes no such mistake, of course, because he is a wise man who has done some hard thinking about education. But a lesser educator, using the procedures Conant seems to recommend, might come to some very dangerous and misleading conclusions and justify them on the basis of his own long experience

and extensive observations. This has frequently happened in the past.

The basic question raised in this book, and the one that provides the title, is whether the ultimate responsibility for education should rest with the state, the parent, or the child. Traditionally, in our society, the parent has been responsible, although the state has long required him to send his child to some kind of a school. But during the first half of this century, with the coming of the elective system and the increased permissiveness of parents, more and more responsibility has been placed on the student to choose his own path. The result has been that many able students chose the easy subjects in high school and some dropped out of school before their talents had been fully developed.

"World War II," says Conant, "provided the first shock to citizens and to educators who started from the premise of the independence of each child if not of each parent. What was accomplished or not accomplished in school or college obviously did have a great deal to do with winning the war in the shortest time and with the minimum expenditure of lives. There was, for the time being at least, an overriding state interest. . . ."

The launching of the sputnik and the development of intercontinental ballistic missiles by the Russians aroused fresh public interest in the quality of our education, and it now seems obvious to many Americans that our national survival, as well as social progress, requires that talented students be educated to the upper limits of their abilities. In the secondary school Conant proposes a rigorous academic program for these students, but who is to require that they take it? His conclusion is that such a program should be made available, but that "There is no way in a free country by which organized society can *require* bright students to study hard. . . .A climate of opinion must be created which brings forth in each young person a strong desire to do his or her best in school. Then the school must, in turn, provide the challenging courses and provide a variety so that not only the academically talented but all pupils will feel their studies are worthwhile."

Such a climate of opinion might seem to require a deemphasis on nonintellectual and recreational activities in the school. Gresham's Law works in education as well as in economics, and one way to keep students out of soft courses and time-wasting activities is to not make them available. But Conant proposes no such deemphasis. He wants an even greater variety of offerings to meet the total range of abilities and interests, and a still greater variety of vocational courses. He counts on improved guidance programs to keep talented students out of the soft courses and the inappropriate vocational courses.

None of Conant's proposals are very revolutionary, nor, apparently, are they intended to be. His program for the talented 15 percent is not greatly different from that long recommended for admission to the more selective colleges, except that Conant proposes four years of mathematics and four years of a single foreign language. He gives little special attention to the large number of students who fall below the upper 15 percent, but who, nevertheless, will go to college. This is a serious omission for already well over 30 percent of high-school graduates go on to college, and the percentage rises each year. It seems unwise to encourage, or even to allow these students, many of whom will enter teaching or other professions, to take easy courses or vocational courses in high school. Conant's proposed required program for the less talented 85 percent is similar to that now required in many high schools: four years of English, three or four of social studies (including two of history), one of mathematics, and one of science, with the remainder of the time to be filled in with electives, including vocational courses. His emphasis on ability-grouping is sound, but this, too, is now found in many schools, and the practice is spreading.

While Conant calls for "immediate action to improve the high school," he believes that "The road to better schools might be considered merely a widening, straightening, and improvement of the present rather overgrown and winding lane along which most children wander." This will give comfort to many who have defended the present system, or lack of system, for it suggests that nothing really basic is wrong and that all necessary improvements can be made without a change in the present pattern of education.

The question must be asked whether Conant's proposals really get to the heart of the problem of educational quality. He is right in saying that we cannot adopt any European system, that we must work within the framework of our own form of democracy and must provide for the full range of individual differences. But some of us who have struggled with these problems for many years are convinced that merely "widening, straightening, and improving," is not enough: we are convinced that the time has come for a more thorough overhaul that will include the junior as well as the senior high-school, provide for better articulation of secondary education with that which comes before and after, and prepare bright students for college a year or two earlier.

The changes that are needed, and in all probability soon will come, will go far beyond the Conant proposals and will include improvements in the teaching-learning process, as well as changes in school organization. They will include a reallocation of space, time, and personnel in the schools, the introduction of team-teaching, more and better instruction by television, and the use of teaching machines where appropriate, so that the teacher's time can be used more effectively. These changes will provide better education for the rural child without requiring him to spend many futile hours each day on a school bus.

New and better kinds of teachers will be necessary, and these will be developed through improved approaches to teacher-education, including the Master of Arts in Teaching program which Conant himself introduced when he was president of Harvard.

If this vision of the future becomes reality, Conant's proposals for the improvement of the American high-school will, by 1970, seem modest indeed. But *The Child, the Parent, and the State* will long be read as a wise and scholarly analysis of the problems of secondary education in a democracy.

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Tree Maintenance. P. P. Pirone, Oxford University Press, New York, ed. 3, 1959. xviii + 483 pp. Illus. $10.

P. P. Pirone is well qualified to present tree maintenance in a comprehensive manner. He has a background as a scientific investigator in plant pathology, and he has also maintained close contact with professional arborists. First published in 1941 as *Maintenance of Shade and Ornamental Trees*, this third revised edition is an excellent reference for the

student, home-owner, nurseryman, landscape architect, and professional arborist.

General maintenance practices are brought up-to-date in part 1. Topics such as soil, transplanting, fertilizers, pruning, treatment of wounds and cavities, and bracing are adequately covered. Major revisions have been made in the chapter on trees suitable for various locations; tall-growing trees are given only passing attention, and more emphasis is placed on low-growing trees suitable for use about low, modern homes and also for streetside plantings.

Specific abnormalities of trees are discussed in part 2. Three main chapters deal with the diseases and insect pests that attack low-growing, tall-growing, and evergreen trees. Each group of trees is arranged in alphabetical order according to the common names. The diseases are presented in logical order—symptoms, cause, and control. Next each insect pest is identified by a description of its damage to the tree and a brief description of the various stages of development. The description is followed by a discussion of appropriate control measures. New diseases and insect pests and the latest methods of controlling them are included.

A new topic is presented in the appendix, which should appeal to professional workers. It is a method for evaluating shade trees from a monetary standpoint adopted by the National Shade Tree Conference and the National Arborist Association in 1957. This is followed by a 19-page, selected bibliography that is especially useful to the student.

Pirone has successfully presented his subject in a manner midway between the technical and the popular levels of presentation.

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Radiation Hygiene Handbook. Hanson Blatz, Ed. McGraw-Hill, New York, 1959. 926 pp. Illus. $27.50.

Hanson Blatz writes in the preface of this *Handbook* that it is the first comprehensive handbook in the field that they chose to call "radiation hygiene" and that the handbook has been dependent upon the contributions, advice, and inspiration of many of the American leaders in this "relatively new branch of science."

The new description of the field as "radiation hygiene" seems very opportune and is a good substitute for the less apt term "health physics" which, if we consider the meaning of "physic," seems at times to be somewhat more appropriate to the field of patent medicines. Disappointingly, however, the information in the handbook seems sometimes to be insufficiently up-to-date to do justice to the newness of this "relatively new branch of science," but this is probably due to the delays that are inevitable in publishing a large and comprehensive work. It is, however, somewhat incongruous to find 102 pages devoted to nuclear data tables "based principally on the work of J. M. Hollander, I. Perlman and G. T. Seaborg" which appeared in *Reviews of Modern Physics* in April 1953 when a very full and complete revision of that work appeared in the same journal in April 1958. Nor is any reference made to the intervening encyclopedic publications of the Nuclear Data Group of the National Research Council (K. Way, C. L. McGinnis, *et al.*).

In the table on fundamental constants in the section entitled "Reference data," it is curious to find the "rutherford," which was stillborn some 9 or 10 years ago. In passing, one might question the validity of including quantities such as the roentgen and curie (and even millicurie and microcurie) as *fundamental constants* along with Avogadro's number, Planck's constant, and the velocity of light.

Apart, however, from the shortcomings of which the foregoing are examples (doubtless they are due to the time elapsed between setting pencil to paper and the ink drying on the printed page), this volume contains a wealth of information in its 23 sections which range from "Exposure standards and radiation protection regulations" through "Interaction of radiation with matter" and "Radiation attenuation data" to "Liquid and solid waste disposal" and "Personnel control." Sections are also devoted to sources of radiation (including natural and artificially induced radioactivity, particle accelerators, and reactors), radiation detection and measurements, and applications to industry, research and medicine. Each section of the book is contributed by an authority in his field.

One omission is, however, noteworthy. In the descriptions of counting equipment much space is devoted to how counters operate but none at all, as far as I can determine, to how to use them. Thus, references are made to the efficiency of counters and formulas are quoted which include efficiency terms, but no clue to the determination of efficiencies is given, nor, indeed, is any difference drawn between geometric and intrinsic efficiency. Such efficiencies are normally determined by the use of radioactivity standards, but a careful search of the subject index and of the most likely parts of the text reveals not one single reference to radioactivity standardization. This is a topic that might well have merited a section of its own, when one considers how the older field of health physics depended so much on radioactive metrology.

That this new and interesting book will be of great value cannot be doubted, and it will be a most valuable asset for any radiation laboratory. It may, however, be of more use to the experienced radiation hygienist, who already knows his way around the field, than to the beginner. There is much that will be of value to the beginner, and the book is stimulating enough to make one look forward to the second edition which could well prove to be a much needed work of authority for all workers, both inexperienced and experienced, in radiation hygiene.

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J. M. Charcot, 1825–1893, His Life—His Work. Georges Guillain. Edited and translated by Pearce Bailey. Hoeber, New York, 1959. 202 pp. + plates. $7.

This is a pleasant little book with a Gallic flavor that is maintained in the translation and with a binding that attracts the eye and hand. How nice to see a little gilt filigree on a cover again.

This is the first English biography of Jean-Martin Charcot, father of modern clinical neurology and one of the medical luminaries of the 19th century. Charcot belongs to that select group of clinicians who have advanced medicine through meticulous, persevering observations of patients throughout the course of their illness and on to autopsy.

Charcot was fortunate in his environment. His work was his life, and he was not disturbed in his pursuits. A proud Parisian, he made the collection of human discards at Salpêtrière his

rich museum and laboratory. This led to his descriptions of neurologic syndromes that will be retained in medicine until clarification of their etiologies; even then, Charcot's name will be indelibly part of their recognition.

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Indians of the High Plains. From the prehistoric period to the coming of Europeans. George E. Hyde. University of Oklahoma Press, Norman, 1959. xiii + 233 pp. Illus. $4.

George Hyde has undertaken the formidable and challenging task of presenting a "coherent picture" of the Indian occupancy of the western plains prior to the year 1800. Mainly, the story is one of the Plains Apache who dominated the central and southern plains from about 1500 to 1700, and of the Comanche and Shoshone ("Snakes") who overran much of the central and northern plains during the 18th century. The data utilized come largely from historical documents, buttressed here and there by archeological evidence turned up in the past quarter century. Three maps and 14 plates (the latter including two particularly interesting mid-18th century deerskin paintings believed to relate to the contemporary Plains Indians) supplement the text.

The author has assembled an impressive body of data, much of it from obscure sources which present-day students too often overlook or neglect in their piecemeal treatment of certain segments of the larger problem. Steeped in years of thinking and reading, Hyde has earned the gratitude of his readers for his region-wide interpretations and for compiling a plausible reconstruction of human activity against which future findings and interpretations can be compared. The end result of his labors makes entertaining reading for anyone dogged enough to stay with the book through its mass of detail and frequent shifts of locale.

The preface describes this as "a reading book, not a treatise"; hence the author disavows a need for the careful documentation that should characterize any scholarly work and which readers have come to expect in this "Civilization of the American Indian Series," of which this is the 54th volume. More serious is the author's penchant, where direct documentation or other supporting evidence is lacking, for suggesting a tentative identification or interpretation and, thereafter, for handling these suggestions as established facts. Because many of the documents for this period are decidedly sketchy and vague and because they frequently use tribal designations which are not readily correlated with the better documented groups of later periods, other interpretations than those set forth still merit serious consideration. Sharp reactions to many of Hyde's views must be anticipated.

Despite these and other shortcomings—a certain archeological naiveté, and the need for healthy skepticism on the part of the reader—Hyde's book should have a place on the shelf of anyone seriously interested in the early historic Indians of the western plains.

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Smithsonian Institution

Report on the State of Machine Translation in the United States. Yehoshua Bar Hillel. Technical Report No. 1. Prepared for the U.S. Office of Naval Research, Information Systems Branch, Jerusalem, Israel, 1959 (available as PB151746 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C.). 48 pp. + appendixes. $2.25.

This critique is a sobering evaluation of the many misconceptions engendered by overly optimistic approaches to fully automatic, high-quality machine translation (FAHQMT). It is based upon the author's visits in late 1958 to most of the 12 major mechanical translation (MT) centers in the United States, discussions with members of the two British centers, and a study of the principal publications of all these centers.

It recommends that fully automatic, high-quality machine translation be renounced and that future practical research be concentrated on either fully automatic, low-quality translation or partly automatic, high-quality translation; it further recommends that basic research into language structure, models, and so forth be divorced from immediate applicability to mechanical translation. Ten proposals for the organization of further research and for the improvement of cooperation are made.

The appendixes include copies of two papers, presented before international conferences, on the theoretical limitations of FAHQMT and an original paper entitled "A demonstration of the non-feasibility of fully-automatic high-quality machine translation."

Speculating on the author's dim view of the possible success of mechanical translation, one might point out that it is easy to construct hypothetical phrases (as the author has done) which cannot be translated by any conceivable machine; this is so easy, in fact, that much of what is written is unintentionally untranslatable, either by machine or human being. If a passage isn't meaningful and unambiguous in the original language, then attempts to translate it into something meaningful are not even a proper activity. In such cases one is tempted to rewrite the passage, and if this is done, it should be recognized that it is not a translation, but the work of a new author. The point here is that since, to a degree, the benefits of mechanical translation are denied us by the machine's intolerance of sloppy communication, we should be more precise in our writing, and if necessary develop a language that permits the necessary degree of precision and nonambiguity.

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MENDALL S. THOMPSON
Science and Technology Division,
Library of Congress

Elements of Solid State Theory. Gregory H. Wannier. Cambridge University Press, New York, 1959. 269 pp. $6.50.

In this volume, Wannier presents us with a readable and cogent account of a considerable segment of modern, solid-state theory. The volume is limited to a size which will not discourage a reader seeking a cultural acquaintance with the subject. It is, however, a book for the physicist, and most topics are discussed at a high level of sophistication.

Two of the early chapters (chapters 3 and 4) have a special value for they treat topics which have only recently attained prominence in the literature of physics and which are therefore not treated in the familiar textbooks. Chapter 3 is devoted to lattice dynamics and includes a discussion of topological aspects of the distribution of the vibrational frequencies of crystals. The recognition of the influence of special points on the form of the frequency

distribution function is probably the most important piece of qualitative insight into the form of the frequency distribution since the introduction of the Debye model, and I am pleased to see it presented so lucidly here. A large fraction of chapter 4, entitled "Co-operative phenomena in solids," consists of a discussion of the Ising model and its application to a variety of solid state, cooperative phenomena and constitutes a brief but excellent review of this subject. The subsequent chapters deal mainly with the electronic properties of crystals, including energy band theory, transport theory, and electronic bonding.

Naturally, in a book of this nature many important details can only be hinted at, and many topics must be omitted altogether. Each reader will be able to choose some favorites from among the latter. However, the book can be recommended almost without reservation to anyone who has a good foundation in quantum mechanics as an excellent survey of the important ideas of modern solid state theory.

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New Books

Advances in Astronautical Sciences. vol. 4. Plenum Press, New York; Chapman and Hall, London, 1959. 460 pp. $8. This volume is a record of both special lectures and technical papers presented at the American Astronautical Society's fifth annual meeting, which was held in conjunction with the 125th meeting of the AAAS. The contents of the volume are "Space exploration and human welfare" (H. L. Dryden); pt. 1, "Upper atmosphere research and re-entry mechanics"; pt. 2, "Space vehicle design"; pt. 3, "Guidance and instrumentation"; pt. 4, "Satellite mechanics and space exploration"; pt. 5, "Rockets and satellites"; pt. 6, "Man's environment in space"; "The flight of the monkey in the joint Army-Navy biological experiment" (N. Barr); "Survival of terrestrial micro-organisms under simulated martian conditions" (J. D. Fulton); "On the relation of oxygen consumption to oxygen tension" (D. E. Beischer); "Atmosphere contaminants and their control" (G. J. Duffner).

Advances in Electronics and Electron Physics. vol. 11. L. Marton, Ed. Academic Press, New York, 1959. 534 pp. $15. Contents: "Recent advances in photoemission," P. Gorlich; "Parity nonconservation in weak interactions," R. M. Sternheimer; "Quantum efficiency of detectors for visible and infrared radiation," R. C. Jones; "Automatic data processing in the physical sciences," G. E. Barlow, J. A. Ovenstone, F. F. Thonemann; "Operational amplifiers," R. L. Konigsberg; "Radio telemetering," H. B. Riblet; "Electron diffraction structure analysis and the investigation of semiconducting materials," Z. G. Pinsker; "Secondary electron emission from solids," O. Hachenberg and W. Brauer.

Anatomy and Physiology. vol. 2. Edwin B. Steen and Ashley Montagu. Barnes and Noble, New York, 1959. 334 pp. Paper, $2.50.

Applications of the Theory of Matrices. F. R. Gantmacher. Translated and revised by J. L. Brenner, D. W. Bushaw, S. Evanusa. Interscience, New York, 1959. 326 pp. $9.

Atomic Energy in the Communist Bloc. George A. Modelski. Melbourne Univ. Press, Melbourne, Australia; Cambridge Univ. Press, New York, 1959. 226 pp. $5.50.

Canadian Cancer Conference. vol. 3. R. W. Begg, Ed. Academic Press, New York, 1959. 475 pp. $12. Contents: "Nucleic acids," "Genetics," "Viruses and tumors," and "Biology of cancer."

The Chemistry of Heredity. Stephen Zamenhof. Thomas, Springfield, Ill., 1959. 117 pp. $4.25.

Engineering Mechanics. Dwight F. Gunder and Derald A. Stuart. Wiley, New York; Chapman and Hall, London, 1959. 402 pp. $7.75.

Fundamentals of Electronics. F. H. Mitchell. Addison-Wesley, Reading, Mass., ed. 2, 1959. 271 pp. $6.50.

General Meteorology. Horace Robert Byers. McGraw-Hill, New York, ed. 3, 1959. 550 pp. $9.50.

Grass Productivity. André Voisin. Translated from the French by Catherine T. M. Herriot. Philosophical Library, New York, 1959. 367 pp. $15.

Inside the U.S. Patent Office. The story of the men, the laws, and the procedures of the American patent system. Harry Kursch. Norton, New York, 1959. 189 pp. $3.95.

An Introduction to Economic Reasoning. Marshall A. Robinson, Herbert C. Morton, James D. Calderwood. Brookings Institution, Washington, D.C., ed. 2, 1959. 346 pp. $3.

An Introduction to Medical Genetics. J. A. Fraser Roberts. Oxford Univ. Press, New York, ed. 2, 1959. 275 pp. $7.

Inventions, Patents, and Their Management. Alf K. Berle and L. Sprague de Camp. Van Nostrand, Princeton, N.J., 1959. 611 pp. $12.50.

Lectures in Theoretical Physics. vol. 1. Lectures delivered at the summer institute for theoretical physics, University of Colorado, Boulder, 1958. Wesley E. Brittin and Lita G. Dunham, Eds. Interscience, New York, 1959. 421 pp. $6.

Lehrbuch der Organischen Chemie. Paul Karrer. Thieme, Stuttgart, Germany, 1959 (order from Intercontinental Medical Book Corp., New York 16). 1077 pp. $14.30.

The Location of the Synthetic-Fiber Industry. A case study in regional analysis. Joseph Airov. Technology Press of Massachusetts Inst. of Technology; Wiley, New York; Chapman and Hall, London, 1959. 215 pp. $9.75.

The Magnetodynamics of Conducting Fluids. Daniel Bershader. Stanford Univ. Press, Stanford, Calif., 1959. 153 pp. $4.50.

Methods of Experimental Physics. vol. 6, *Solid State Physics.* pt. A, *Preparation, Structure, Mechanical and Thermal Properties,* 482 pp., $11.80; pt. B, *Electrical, Magnetic, and Optical Properties,* 430 pp., $11. K. Lark-Horovitz and Vivian A. Johnson, Eds. Academic Press, New York, 1959.

Modern Adventures under the Sea. Patrick Pringle. Watts, New York, 1959. 240 pp. $3.95.

Men and Atoms. The discovery, the uses, and the future of atomic energy. William L. Laurence. Simon and Schuster, New York, 1959. 315 pp. $4.50.

Our Mineral Resources. Charles M. Riley. Wiley, New York; Chapman and Hall, London, 1959. 348 pp. $6.95.

The Nature of Reading Disability. Donald E. P. Smith and Patricia M. Carrigan. Harcourt, Brace, New York, 1959. 157 pp. $6.

Notes on the Quantum Theory of Angular Momentum. Eugene Feenberg and George Edward Pake. Stanford Univ. Press, Stanford, Calif., 1959. 56 pp. Paper, $1.25.

Pediatric Pathology. Daniel Stowens. Williams & Wilkins, Baltimore, 1959. 689 pp. $20.

Physics, an Exact Science. Harvey E. White. Van Nostrand, Princeton, N.J., 1959. 608 pp. $5.96.

Principles of Human Pathology. Edward B. Smith, Parker R. Beamer, Frank Vellios, Dale M. Schulz, Oxford Univ. Press, New York, 1959. 134 pp. $15.

Principles of Mechanics. John L. Synge and Byron A. Griffith. McGraw-Hill, New York, ed. 3, 1959. 569 pp. $9.50.

Principles of Physical Chemistry. William H. Hamill and Russell R. Williams, Jr. Prentice-Hall, Englewood Cliffs, N.J., 1959. 617 pp. $8.75.

Progress in Cryogenics. vol. 1. K. Mendelssohn, Ed. Academic Press, New York, 1959. 267 pp. $11.

Progress in Drug Research. vol. 1. Ernst Jucker, Ed. Birkhäuser, Basel, Switzerland, 1959. 607 pp. Fr. 68.

Progress in Neurobiology. vol. 4, *The Biology of Myelin.* Saul R. Korey, Ed. Harper, New York, 1959. 429 pp. $9.50. This symposium was supported by the National Institute of Neurological Diseases and Blindness.

Quantum Chemistry Integrals and Tables. James Miller, John M. Gerhauser, F. A. Matsen. Univ. of Texas Press, Austin, 1959. 1125 pp. $15.

Readings in Urban Geography. Harold M. Mayer, and Clyde F. Kohn, Eds. Univ. of Chicago Press, Chicago, Ill., 1959. 632 pp. $8.50.

Relativity for the Layman. A simplified account of the history, theory, and proofs of relativity. James A. Coleman. Macmillan, New York, 1959. 137 pp. $3.50.

Space Handbook. Astronautics and its applications. Robert W. Buchheim *et al.* Random House, New York, 1959. 346 pp. $3.95.

Virus Hunters. Greer Williams. Alfred A. Knopf, New York, 1959. 516 pp. $5.95.

Reports

Cache Valley Virus, a Previously Undescribed Mosquito-Borne Agent

Abstract. Cache Valley virus was isolated from *Culiseta inornata* mosquitoes collected in Utah. The newly isolated agent causes signs of encephalitis in mice inoculated intracerebrally. It has been classified with the Bunyamwera group of anthropod-borne (Arbor) viruses.

During routine testing of wild-caught mosquitoes for the presence of western and St. Louis encephalitis viruses, an agent was recovered which appears to be unlike previously described mosquito-borne viruses of North America. The new isolate has been named Cache Valley virus for the locality from which the infected mosquitoes were collected.

Cache Valley virus was isolated from a pool of 50 *Culiseta inornata* mosquitoes collected on 16 Aug. 1956 under a bridge near the town of Wellsville in Cache Valley, northern Utah. Signs of encephalitis were observed in each of six weanling mice used for the initial isolation attempt (*1*). Most of the test mice were found in a moribund state 8 to 10 days after inoculation, and all had died by the 13th day. Three weeks later the virus was again recovered in mice inoculated with a stored portion of the original mosquito suspension. The agent obtained from these tests possessed the usual characteristics of viruses: it passed readily through a Seitz filter; no growth was obtained on common laboratory media inoculated with mouse-brain suspensions containing the agent; and its infectivity was not reduced by the addition of antibiotics.

Cache Valley virus was adapted to growth in weanling mice with considerable difficulty. The LD_{50} titer of a fourth-passage mouse-brain suspension was only $10^{-4.6}$. Significantly higher titers were not obtained through 11 passages in mice of this age. After the 12th passage, the agent was propagated in 2- to 3-day-old mice. The 14th mouse-passage virus stock, prepared from infant mouse brain, had an LD_{50} titer of $10^{-7.7}$ in weanling mice.

In further studies of Cache Valley virus the following results were obtained. (i) The virus was immunogenic, but not pathogenic, for rabbits inoculated via the intramuscular route. (ii) It was pathogenic for infant mice inoculated either by the intraperitoneal or intracerebral route. (iii) It was not pathogenic for weanling mice inoculated intraperitoneally or subcutaneously. (iv) It apparently was not infectious for 0.5-day-old chicks; chicks inoculated subcutaneously with large doses of Cache Valley virus did not develop a viremia, and, furthermore, neutralizing antibodies against the agent were not demonstrable in their serum 30 days later. (v) The virus produced cytopathogenic effects in tissue-culture cells grown from hamster kidney. (vi) Evidence was found suggesting that horses may become infected with Cache Valley virus under natural circumstances. Serum specimens from four horses living in Cache Valley were considered positive in mouse-neutralization tests (*2*). In these tests, neutralization indexes of 50, 80, >320, and >500, respectively, were obtained. Negative results were obtained in similar tests on serums from three other horses and five human beings from the same vicinity.

Cache Valley virus in third mouse passage was sent to the Rockefeller Foundation Virus Laboratories in New York, where Casals and Whitman found it to be serologically distinct from the viruses of Arbor groups A, B, and C and found that it belongs, instead, to their newly designated "Bunyamwera group" (*3*). In addition to Cache Valley virus, this group includes the following viruses: (i) *Bunyamwera,* isolated by Smithburn *et al.* (*4*) from a mixed pool of *Aëdes* mosquitoes collected in Uganda, British East Africa; (ii) *Wyeomyia,* isolated by Roca-Garcia (*5*) from *Wyeomyia melanocephala* mosquitoes collected in Colombia, South America; and (iii) Kairi virus (TR8900), isolated from *Aëdes scapularis* mosquitoes collected in Trinidad, British West Indies (*6*).

Apparently, the distribution of Cache Valley virus is not confined to Utah. Immune serum prepared against an agent isolated from *Culiseta inornata* in the National Institutes of Health's Rocky Mountain Laboratory, Hamilton, Montana (*7*), protected against three logs of Cache Valley virus in mouse-neutralization tests. Casals and Whitman (*3*) report that an agent indistinguishable serologically from Cache Valley virus was isolated by O. R. Causey from *Aëdes scapularis* mosquitoes collected near Belém (Pará), Brazil. Another virus apparently identical to or very closely related to Cache Valley virus has been recovered by Aitken (*8*) from *A. scapularis* collected in Trinidad, British West Indies.

It seems reasonable to assume that the recovery of Cache Valley virus represents a bona fide isolation from mosquitoes. None of the other viruses in the "Bunyamwera group" has ever been in our laboratory. Additional evidence was the reisolation of Cache Valley virus from the original mosquito pool, and the finding that Cache Valley virus was "neutralized" by sera obtained from horses living in the same area from which the mosquitoes were collected.

The possible importance of Cache Valley virus to the health of human beings or animals is not known. However, it is recognized that the causal agents in many cases of disease of the central nervous system among various animal species remain unidentified each year. Therefore, further studies are planned to determine the pathogenesis of Cache Valley virus in experimentally infected animals, the host range of the virus in nature, its natural mode of transmission, and whether or not naturally acquired Cache Valley virus infections may result in disease in man or other animal species.

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References and Notes

1. Mosquitoes were suspended in 33⅓-percent normal inactivated serum-saline diluent containing antibiotics. The resulting suspension was inoculated into 3- to 4-week-old mice via the intracerebral route.
2. In mouse-neutralization tests, constant amounts of serum were mixed with serial tenfold dilutions of virus. After incubation at 37°C for 2 hours, the serum-virus mixtures were inoculated into weanling mice via the intracerebral route.

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

3. J. Casals and L. Whitman, *Am. J. Trop. Med.*, in press.
4. R. C. Smithburn, A. J. Haddow, A. F. Mahaffy, *Am. J. Trop. Med.* **26**, 189, 208 (1946).
5. M. Roca-Garcia, *J. Infectious Diseases* **75**, 160 (1944).
6. C. R. Anderson, T. H. G. Aitken, L. Spence, W. G. Downs, *Am. J. Trop. Med.*, in press.
7. The serum was provided through the kindness of Carl M. Eklund of the Rocky Mountain Laboratory.
8. T. H. G. Aitken, personal communication.

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2 July 1959

Resistance to Deformation of Axial Structures in Living Guinea-Pig Spermatozoa

Abstract. Rotation of living guinea-pig spermatozoa can be effected by drawing the shaft of a long microneedle of diameter 0.5 to 1.0 μ across the tail; the special characteristics of this rotation demonstrated in the tail a polygonal structure and high resistance of the peripheral fibrils to deformation by pressure of the microneedle.

In the course of research on fragility (in immune reactions) of guinea-pig spermatozoa (*1*) during which use was made of micromanipulation to effect dissection of living spermatozoa, it was observed that it was easily possible to rotate an immobilized spermatozoon by drawing a long glass rod (or long shank of a microneedle) at right angles to the length of the spermatozoon across the tail, approximately halfway between the midpoint and the body. This was effected by making the diameter of the needle close to the diameter of the tail (Fig. 1) (in general about 0.5 to 1.0 μ) and about 200 μ or more long.

Fig. 1. Living guinea-pig spermatozoon with two microneedles showing diameter and position for rotation with relation to tail. Phase contrast. (×1150)

The special feature of the rotation of the spermatozoon (shown by rotation of the head) was its positive nature (in that the needle did not slip and rotation was directly proportional to the speed of movement of the needle). This indicated, first, that the tail cannot be round or flat but must possess a basic polygonal structure on section (Fig. 2*a*) in order that the tail may be engaged between the needle and the slide surface (Fig. 2*b*); this polygonal structure is shown by electron microscopy of the tail where a set of nine peripheral fibrils surrounds a double axial thread (Fig. 2*c*). Second, micromanipulation demonstrated that the basic fibrillar structure must be highly resistant to deformation; here electron microscopy shows a thin outer protoplasmic sheath (which contains microsomes) smoothly rounded in outline with a spiral layer outside the peripheral fibrils; a light structureless protoplasm occupies the central region around the axial fibril (Fig. 2*c*).

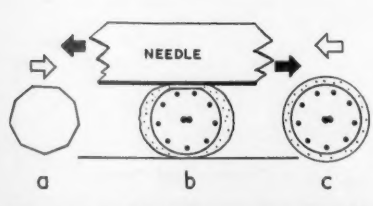

Fig. 2. (*a*) Polygonal structure effective for rotation by movement of needle across surface. (*b*) Tail of spermatozoon on section with suggested deformation of surface protoplasm on pressure of needle; resistance of peripheral fibrils and central protoplasm. (*c*) Normal structure and relative disposition of fibrils in tail (schematic).

This second conclusion on the physical properties of the spermatozoa shown by micromanipulation appears to confirm an early observation on micromanipulation of spermatozoa by Terni (*2*); in addition, observations by Duryee (*3*) on microdissection of *Triturus pyrrhogaster* spermatozoa revealed similar properties in this species.

Deformation of the thin surface protoplasmic layer must take place in order that the needle may be brought in close contact with the fibrils. The question then arises as to why the internal protoplasm, greater in amount than that between and around the peripheral fibrils, does not also deform; if any displacement of fibrils takes place it must be slight since rotation requires persistence of the polygonal structure; these observations also concern the forces which maintain the fibrils in position; the forces not only resist pressure from the surface but resist tension on their long axes without evidence of elasticity; such lack of elasticity is to be expected from the characteristics of the surface resistance.

It would be desirable, and it should be possible, to obtain quantitative data on these forces. The observations presented indicate that the forces will be found to be high among biological materials of fibrillar structure.

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References

1. C. A. Erskine, *Proc. Soc. Study Fertility*, in press.
2. T. Terni, cited by W. Duryee (personal communication).
3. W. Duryee, personal communication.

13 May 1959

Induction of the Respiration-Deficient Mutation in Yeast by Various Synthetic Dyes

Abstract. Series of triphenylmethane and xanthene dyes were found to be effective as inducers of respiration-deficient mutation in yeast. The quantitative difference in the mutagenic effect appeared to be in close relationship to the chemical structure of the respective dyes. This survey may provide a useful clue for elucidation of the mechanism of mutagenic induction.

Among various inducers of the respiration-deficient (*petite colonie*) mutation in yeast, several synthetic dyes show pronounced effects (*1*). The work under discussion deals with a comparative survey of the *petite-colonie*-inducing effects of various dyes in an attempt to seek the relationship, if any, between the chemical structure and the efficacy of the dye as an inducer.

A strain of baker's yeast (Fleischmann) mentioned in an earlier report (*2*) was cultured in a liquid medium

Table 1. Production of mutants by various dyes. Minimal concentration is required to produce more than 3 percent mutants, optimal to produce more than 90 percent.

Dye (Manufacturer)	Concentration (mg/lit)		
	Minimal	Optimal	For entire suppression
Crystal violet* (Merck)	0.2	0.6	2.4
Ethyl violet* (Bayer)	0.2	0.4	2.0
Methyl violet* (Merck)	2.0	4.0	8.0
Malachite green* (Japan)	1.0	3.0	10.0
Pararosaniline* (Japan)	2.0	8.0	50.0
Rosaniline* (Japan)	3.0	8.0	60.0
Victoria blue B* (Japan)	6.0	20.0 (<40%)	30.0
Victoria blue 4R* (Japan)	6.0	10.0 (<60%)	30.0
Pyronine Y† (Bayer)	2.0	6.0	50.0
Pyronine B† (Bayer)	2.0	6.0	50.0
Acridine red 3B† (Japan)	12.0	40.0	100.0
Acriflavine (Japan)	0.4	1.5	12.5
Caffeine (Japan)	1500	2500	3500

* Triphenylmethane dye; † xanthene dye. Acridine red 3B is a xanthene dye in spite of the name.

(yeast extract powder, 0.2 percent; peptone, 0.18 percent; ammonium sulfate, 0.15 percent; monopotassium acid phosphate, 0.1 percent; magnesium sulfate, 0.05 percent) supplemented with the dye to be tested. Fifty milliliters of the medium in 100-ml erlenmeyer flasks were inoculated with about 1000 cells of the original culture per milliliter and incubated at 30°C for 48 hours. A few drops of these cultures were diluted in sterilized water, spread on a normal nutrient agar medium, and scored for *petite* mutants after 48 hours of incubation at 30°C.

Table 1 summarizes the results of the experiments with various dyes in varied concentrations. The effects of acriflavine and of caffeine in the collateral tests with the same basal medium are shown for comparison. Most of the inducers are toxic with respect to the yeast and suppress growth at fairly low concentrations. The increase in the frequency of occurrence of the *petite* mutants is, however, greater in the fully grown cultures (up to 3×10^7 cells per milliliter) than in the inhibited cultures. In other words, maximum induction in terms of increased frequency of the *petite* mutants in the final population appears at concentrations far below the lethal level. Comparison based upon molar concentrations of the dyes instead of on milligrams per liter reveals greater differences in efficacy in both the induction of *petite* mutants and the suppression of growth.

With the exception of acriflavine, the dyes fall into two major groups—namely, triphenylmethane dyes and xanthene dyes. The general trends in the relationship between chemical nature and efficacy may be summarized as follows: (i) all the effective dyes are basic dyes; (ii) efficacy tends to be greater when the number of methyl groups in the molecule is greater; (iii) the aminotriphenylmethane derivatives which have methyl groups introduced into their amino groups are more effective than those which have methyl groups introduced into the benzene nuclei; (iv) the dyes which have ethyl groups instead of methyl groups are as effective as, or sometimes more effective than, the dyes which have methyl groups in the corresponding positions. The Victoria blue dyes B and 4R show rather low efficacy as compared with other triphenylmethane dyes in spite of high affinity (absorption) to the yeast cells. Such characteristics are perhaps due to the presence of a phenyl-α-naphthylamine moiety in the molecule.

An improved modification of the triphenyltetrazolium chloride (TTC) overlay technique was employed for scoring the *petite* mutants in the cultures. The molten agar (1 percent) containing 0.05 percent TTC and 0.5 percent glucose was gently poured onto colonies (200 to 300 per standard petri dish) of the sample cultures growing on nutrient agar of the same composition as the basal medium. The cultures, thus covered 3 to 4 mm deep, were incubated again at 30°C. Color differentiation between normal (red) and mutant (white) colonies appeared more clear-cut and occurred more quickly than color differentiation produced by the procedures hitherto followed (*3*).

The dyes were examined by paper chromatography. The ascending development with acetone, water (4:6) and *n*-butanol, acetic acid, water (4:1:5), respectively, gave fairly good results. No serious admixture or decomposition product has been detected so far (*4*).

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References and Notes

1. B. Ephrussi and H. Hottinguer, *Cold Spring Harbor Symposia Quant. Biol.* **16**, 75 (1951); G. Wild and C. Hinshelwood, *Proc. Roy. Soc. (London)* **B145**, 14 (1955); N. Yanagishima, *Naturwissenschaften* **46**, 151 (1959); W. Laskowski, *Heredity* **8**, 79 (1954).
2. S. Nagai and H. Nagai, *Naturwissenschaften* **45**, 577 (1958).
3. N. Yanagishima, *J. Inst. Polytech., Osaka City Univ.* **D7**, 131 (1956); M. Ogur, R. St. John, S. Nagai, *Science* **125**, 928 (1957).
4. This work was supported in part by a grant from the Ministry of Education of Japan.

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Acid Mucopolysaccharide of the Crustacean Cuticle

Abstract. The acid mucopolysaccharide found in the crab *Hemigrapsus nudus* and containing glucose, galactose, and fucose residues is found both in the cuticle and in the digestive gland of the crab. The concentration of mucopolysaccharide is somewhat higher in the cuticle, where it it the only soluble polysaccharide, than in the digestive gland, where it makes up 10 to 25 percent of the total polysaccharide content.

The occurrence of acid mucopolysaccharides in integumentary and skeletal tissues has been reported frequently in recent years. The present report provides direct chemical evidence of the occurrence of such a substance in the integument and digestive gland of the crab *Hemigrapsus nudus* (Dana). Trim (*1*) reported the occurrence of a nonchitin carbohydrate in the arthropod cuticle. Travis (*2*), using histochemical methods, demonstrated the presence of a mucopolysaccharide in the integument and digestive gland of lobsters. Hu (*3*), in his recent study, observed that a polysaccharide other than glycogen is present in *H. nudus*. The polysaccharide fraction separated by Hu yielded, on hydrolysis, fucose, galactose, and glucose. Nothing was known as to whether this polysaccharide is similar in distribution to that observed by Trim or Travis. Hence, it was thought worth while to study the distribution of this polysaccharide in the crab, with special reference to the cuticle.

The animals were collected from Coos Bay in the vicinity of Charleston, Ore. All the animals used in the experiment were in the C_4 stage of the intermoult cycle (*4*).

The cuticle was prepared according to the method used by Frankel and Rudall (*5*) for insects. The polysaccharides were precipitated with alcohol from alkali extracts of the powdered cuticle and of the fresh digestive gland. The polysaccharides were separated by paper electrophoresis at *p*H 5, as suggested by Bera *et al.* (*6*). The Karler-Kirk curtain-electrophoresis apparatus was used (*7*). The polysaccharide was stained on the paper by the method of Köiw and Gronwall (*8*) and of Hammerman (*9*). Quantitative estimation of the polysaccharides after electrophoretic separation was made by the anthrone method of Roe (*10*). For the hydrolysis of the polysaccharide and analysis of the sugars, the methods adopted by Hu (*3*) were followed.

The digestive gland contains, besides glycogen, an acid mucopolysaccharide which gives a positive test with toluidine blue staining on the paper. The acid mucopolysaccharide moves to the cathode and is readily separated from glycogen on paper during electrophoresis. Hydrolysis of the polysaccharide yielded fucose, galactose, and glucose, glucose being more abundant than the other two sugars, as observed by Hu (*3*). The cuticle also showed the presence of acid mucopolysaccharide which

Table 1. Polysaccharide content of digestive gland and cuticle of *Hemigrapsus nudus*.

Tissue	Polysaccharide			
	Glycogen (mg/100 gm of dry tissues)		Acid* (mg/100 gm of dry tissues)	
	Mean	Extremes	Mean	Extremes
Digestive gland	5073	2506–7392	671	285–2460
Cuticle			939	842–1085

* Expressed in terms of glucose equivalents by the anthrone method.

yielded fucose, galactose, and glucose on hydrolysis and which appeared to be identical with that of the digestive gland. Glycogen was not demonstrable in the cuticle; if it was present at all, the amount was negligible as compared with the acid mucopolysaccharide.

Quantitative distribution of the acid mucopolysaccharide in the cuticle and digestive gland is summarized in Table 1.

The cuticle contains an average of 937 mg of acid mucopolysaccharide per 100 gm (dry weight). In the digestive gland, about 10 to 25 percent of the total polysaccharide is in the form of acid mucopolysaccharide.

Recently many interesting observations on the correlation between calcification and distribution of acid mucopolysaccharide have been reported. Rubin and Howard (*11*) observed acid mucopolysaccharide in association with calcification in bones and calcified cartilages and suggested that calcium-binding capacity was due to the presence of the acid mucopolysaccharide. Studies on various types of human tissues have led to the conclusion that a mucopolysaccharide with specific properties is involved in almost all biological calcification. In the study of the organic matrix of the shell of the hen's egg, Simkin and Tyler (*12*) suggest that both acid mucopolysaccharide and protein components of the egg shell are vitally important to the calcification mechanism. Travis (*2*) has observed that the mucopolysaccharide shows some cyclic changes in the digestive gland and the integument in relation to the intermoult stages. On the basis of these observations it is envisaged that the presence of acid mucopolysaccharide in the cuticle of the crab may have an important role in the calcification of the cuticle (*13*).

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References and Notes

1. A. R. H. Trim, *Biochem. J.* **35**, 1088 (1941).
2. D. F. Travis, *Biol. Bull.* **113**, 451 (1957).
3. A. S. L. Hu, *Arch. Biochem. Biophys.* **75**, 387 (1958).
4. R. W. Hiatt, *Pacific Sci.* **2**, 135 (1948).
5. G. Frankel and K. M. Rudall, *Proc. Roy. Soc. (London)* **B129**, 1 (1940).
6. B. C. Bera, A. B. Foster, M. Stacey, *J. Chem. Soc.* **1955**, 3788 (1955).
7. A. Karler, C. L. Brown, P. L. Kirk, *Mikrochim. Acta* **1956**, 1585 (1956).
8. E. Köiw and A. Gronwall, *Scand. J. Clin. Lab. Invest.* **4**, 244 (1952).
9. D. Hammerman, *Science* **122**, 924 (1955).
10. J. H. Roe, *J. Biol. Chem.* **212**, 335 (1955).
11. P. S. Rubin and J. R. Howard, *Conf. on Metabolic Interrelations, Trans. 2nd Conf.* (1950), vol. 2, p. 155.
12. K. Simkin and C. Tyler, *Quart. J. Microscop. Sci.* **98**, 19 (1958).
13. This work was supported by a grant (G-5692) from the National Science Foundation.

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Titration of the Protein Paramyosin

Abstract. The titration curve of an aqueous solution of crystalline paramyosin shows a unique buffering zone which can be attributed to a shift in the pK of its glutamic acid residues. A possible explanation of this phenomenon on the basis of the presence of polyanionic segments in the molecule is discussed.

In the course of studies on the solubility characteristics of the protein paramyosin and the physiological behavior of muscles containing this protein (*1*), it became apparent that its sharp crystallization point around *p*H 6.4 may be of prime importance to its physiological role. The amino acid composition of paramyosin, as determined by Kominz *et al.* (*2*), shows no amino acid residues which should have a pK in this range. The protein contains less than 1 percent histidine but about 158 residues of glutamic acid, 120 of aspartic acid, 73 each of lysine and arginine, and 13 of tyrosine, out of 800 amino acid residues (100,000 molecular weight); of the carboxylic groups, 112 are present as amides. No significant amount of phosphate could be detected.

We have titrated solutions of paramyosin over the *p*H range from 2 to 12, in the hope of determining whether or not crystallization is associated with pecularities in the titration curve.

The procedure was as follows. Paramyosin, isolated as previously described (*1*), was dissolved in 0.3*M* KCl and dialyzed against water. The precipitated paramyosin was isolated by centrifugation and dissolved in 0.3*M* KCl to give a final concentration of 1 percent protein. Thirty milliliters of this solution was placed in a beaker above a magnetic stirrer, under a nitrogen atmosphere, and adjusted to *p*H 12 with KOH. The solution was then titrated with 0.1*N* HCl, with a microburette, and the *p*H was read continuously with a Beckman model G *p*H meter with external electrodes. A blank, consisting of 30 ml of 0.3*M* KCl, was titrated over the same *p*H range, and its curve was subtracted from that of the protein sample. The results, designated as the net titration curve, are shown in Fig. 1. The protein precipitated at a *p*H value near 6.5, as had previously been found to be the case (*1*). The precipitation did not in itself alter the behavior of the protein toward added acid, since it was possible to start on the acid side of the curve with precipitated protein and titrate in the opposite direction with no change in the shape of the curve.

The titration curve shows a buffering zone around *p*H 11.5, corresponding to the known arginine content of the protein. The large buffering zone around *p*H 10 corresponds to the lysine, tyrosine, and terminal amino groups. A large buffering zone is found near the center of the curve, with a pK of about 6.3, corresponding to the titration of 130 groups per 800 amino acid residues. No buffering zone for carboxyl groups is found around *p*H 4.3, although such a zone would have been expected on the basis of the known content of glutamic acid. The buffering zone at the low *p*H end of the curve could correspond to free aspartic acid residues as well as terminal carboxyl groups.

The complete absence of a buffering zone around *p*H 4.3 and the presence of a large zone around *p*H 6.3 suggest that the pK' of the glutamic acid residues present in the protein has been shifted by approximately 2 *p*H units. Such large shifts in pK' are not common in proteins but are common in synthetic polymers. In the case of synthetic polyanions, the shift has been accounted for on the basis of the strong electric field which appears when charges are concentrated along the polymer chain (*3*). Others have sought to explain this effect in proteins on the basis of hydrogen bonding (*4*) or masking of groups by bound water (*5*). However, in view of the solubility behavior of paramyosin, the possibility that polyanionic segments are present in this protein sounds attractive to us.

This possibility has prompted us to calculate the number of charges per unit length of protein molecule necessary to generate an electric field large enough to shift the pK of the glutamic acid residues by approximately 2 *p*H units. The following formula, derived by Hartley and Roe (*6*) and modified by Katchalsky (*7*), for polyanions in solution, was used:

$$pH = pK' - 1n\frac{1-\alpha}{\alpha} + \frac{0.4343\,\varepsilon\,\psi}{kT} \quad (1)$$

where pK' is the pK' of the monomeric group (in this case 4.3), T is the abso-

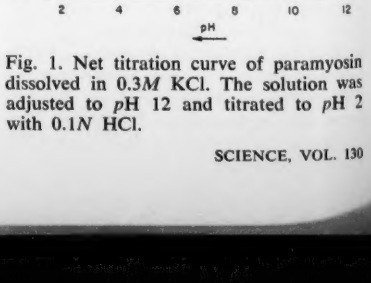

Fig. 1. Net titration curve of paramyosin dissolved in 0.3*M* KCl. The solution was adjusted to *p*H 12 and titrated to *p*H 2 with 0.1*N* HCl.

lute temperature, a is the degree of dissociation of the monomeric group, ψ is the electric field, k is Boltzmann's constant, and ε is the elementary electronic charge. On the assumption that half-dissociation of the monomeric group in Fig. 1 occurs at *p*H 6.3, the electric field (ψ) was calculated to be approximately 100 mv. The surface-charge density necessary to generate a field of this strength was calculated from the following expression derived by Overbeek (*8*) (the Göuy-Chapman model of an electric double layer was used, and it was assumed that the molecular surface roughly approximates a plane surface):

$$\sigma_0 = \sqrt{\frac{DcRT}{2\pi}}\, 2 \sinh\left(\frac{F}{2RT}\frac{\psi_0}{}\right) \qquad (2)$$

where σ_0 is the surface-charge density, c is the concentration of the counterions in the medium at infinite distance from the face of the molecule, D is the dielectric constant of the medium, R is the gas constant, and F is Faraday's constant; the other terms are the same as those appearing in Eq. 1. The value for σ_0 was found to be 1.5×10^{14} charges/cm^2. This corresponds to 2.4 charges per 5.1-A length of a cylinder having a diameter of 9.8 A. On the assumption that the polypeptide chains within the paramyosin have the form of an a-helix (*9*), a polyglutamic acid segment could have a maximum of 3.8 charges per 5.1-A length.

The possibility that the high charge density is due to the presence of polyglutamic acid segments along the molecule can be tested by partial digestion of the paramyosin and examination of the fragments formed for the presence of highly acidic polypeptides. Preliminary studies with paper electrophoresis, in which tryptic digests of paramyosin were used, have indicated the presence of a fast-moving negative component which could correspond to a polyanion (*10*).

Note added in proof. Kensal Van Holde of the chemistry department, University of Illinois, has calculated by an independent method the charge density that could give rise to the suggested shift in pK' of the glutamic acid residues in paramyosin. He has used the model proposed by T. Hill [*Arch. Biochem. Biophys.* **57**, 229 (1955)] which consists of a charged cylinder of infinite length, radius b, and closest center-to-center approach for small external ions of distance a. The titration curve should, in the region of the pK' of the above groups, be expressed by

$$p\mathrm{H} = p\mathrm{K}' + 1\mathrm{n}\,[\alpha/(1-\alpha)] - \frac{0.868w(c-\alpha n)}{}$$

where α is the fraction of groups ionized, n is the total number of acid groups, c is the number of positive groups in the neighborhood, and $w = F_e/Z^2KT$ [Z is the actual charge and F_e is the electrostatic free energy for charging the model in question, the expression for which is given by Hill (see above)]. For a shift of pK' of 2.0 *p*H units, assuming that cationic groups are sufficiently remote to be neglected in this calculation and that the cylinder has the radius of an α-helix ($a = 7$ A; $b = 5$ A), the number of charges in a length of 5.1 A is 3.7.

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References and Notes

1. W. H. Johnson, J. S. Kahn, A. G. Szent-Györgyi, *Science* **130**, 160 (1959).
2. D. R. Kominz, F. Saad, K. Laki, *Proceedings of the Conference on the Chemistry of Muscular Contraction, Tokyo, Japan* (1956), p. 66.
3. A. Katchalsky, in *Progress in Biophysics and Biophysical Chemistry*, J. A. V. Butler and J. T. Randall, Eds. (Academic Press, New York, 1954), vol. 4, p. 1.
4. M. Laskowsky, Jr., and H. A. Sheraga, *J. Am. Chem. Soc.* **76**, 6305 (1954).
5. I. M. Klotz, *Science* **128**, 815 (1958).
6. G. S. Hartley and J. W. Roe, *Trans. Faraday Soc.* **36**, 101 (1940).
7. A. Katchalsky, *J. Polymer Sci.* **12**, 393 (1951).
8. J. T. G. Overbeek, in *Colloid Science*, H. R. Kruyt, Ed. (Elsevier, Amsterdam, Netherlands, 1952), p. 115.
9. A. G. Szent-Györgyi and C. Cohn, *Science* **126**, 697 (1957).
10. We thank George Karreman of the Eastern Pennsylvania Psychiatric Institute for help in the theoretical aspects of this work. We are also deeply grateful to Andrew G. Szent-Györgyi for a generous supply of crystalline paramyosin.
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30 July 1959

On the Mechanism of Action of Chlorpromazine

Abstract. Chlorpromazine is shown to be a powerful electron donor. Observations are described supporting the assumption that the therapeutic action of this drug is connected with this property.

Redox reactions between organic substances as a rule involve a change between two forms differing by two H atoms (two electrons plus two protons). Michaelis (*1*) pointed out that in this process the electrons may transfer one by one, and he demonstrated the intermediate state. Accordingly, substances regarded as oxidants or reductants are expected to have two stable configurations differing from each other by two hydrogen atoms.

J. Weiss (*2*) discovered that complexes may have properties which indicate an electron transfer from one molecule to the other within the complex. Mulliken (*3*) and his associates further developed this theory of "charge transfer." In such charge-transfer complexes an electron is supposed to go from the highest filled orbital of the donor to the lowest empty orbital of the acceptor; this transfer involves no change in configuration in classical chemical terms. In most cases studied by Mulliken the electron donated spent only a small fraction of its time with the acceptor and needed additional energy, supplied by the absorption of light, to be almost completely transferred to the acceptor.

The findings obtained in one of our laboratories indicated that complexes may be formed by biologically important substances in which an electron is practically wholly transferred from the donor to the acceptor, even in the ground state. There was reason to believe that such charge-transfer reactions are a frequent occurrence and so may play a role in reactions connected with a transfer of energy. The question arose whether charge transfer might play a role in the mechanism of drug action. Preliminary experiments indicated that this may be the case. For instance, various alkaloids were found to act readily as donors in complexes with iodine dissolved in chloroform.

Chlorpromazine has striking biological activity. It is, therefore, of great interest that, as indicated in this report, chlorpromazine also has striking properties as an electron donor, and the question arises whether the tranquilizing action of this drug may not be due to its charge-transfer properties. It is not possible to predict from its biological activity whether a pharmacologically active substance is an electron acceptor or an electron donor. If the drug acted, for example, on the electric double layer on the cell surface, where there is a positive charge on the outside and a negative charge on the inside, then an electron transfer on the outside would lead to a depolarization and thus to excitation, while a donation on the inside could be expected to lead to a hyperpolarization and, with it, to inhibitions. So, the final action depends on the affinities and location. What can be said, in a general way, is that one would expect pharmacological activity from a good donor rather than from a good acceptor, since the charge transfer depends to a great extent on the overlap of wave functions and a strong donor property involves a rather extended wave function. Whatever the case may be, one would expect pharmacological agents to show exceptionally strong donor or acceptor properties if their biological activity is actually due to a charge transfer.

With these thoughts in mind, the electron levels of chlorpromazine have been calculated by means of the LCAO method. The K values obtained were -0.217 for the highest filled, and -1.000 for the lowest empty orbital (*4*). This finding is rather striking and unexpected. To our knowledge, chlorpromazine is the first substance ever found in which, in its ordinary stable state, the highest filled level corresponds to an antibonding orbital, as indicated by the minus sign of K. This makes chlorpromazine a quite extraordinarily strong electron donor. Negative values for highest orbitals were hitherto found only in substances on which H atoms were forced by reduction of the molecule in question, as in leucomethylene blue (MBLH) and reduced flavin mononucleotide ($FMNH_2$) (*5*).

In phenothiazine the highest filled molecular orbital also has a negative value and is antibonding (K of the highest filled orbital is -0.210 and K of the lowest empty orbital is -1.000). So, evidently, the strong donor properties of chlorpromazine are linked to the phenothiazine part of the chlorpromazine.

The assumption that charge transfer may be involved in pharmacological reactions of chlorpromazine is supported by the fact that we found *d*-lysergic acid diethylamide, another drug with strong action on the central nervous functions, to be a very good donor. The K value of the highest filled orbital was found to be 0.218; of the lowest empty orbital, -0.726. Also, serotonin is a very good donor, more so than indole or tryptophan (K of the highest filled electronic orbital, 0.461; of the lowest empty orbital, -0.870), and it also has a strong action on the central nervous system. (This agreed with absorption measurements of the complexes (*6*) of these substances, which also indicate that serotonin is a good donor, better than tryptophan.)

The calculations are supported by the chemical behavior of the substances in question. The negative values for MBLH and $FMNH_2$, as pointed out by B. Pullman and A. Pullman, is supported by the great instability of these substances, which readily undergo autooxidation in the presence of O_2. Chlorpromazine, which is not readily autooxidizable, at least not in the dark, is thus unique also in being relatively stable in spite of its energy values. However, the strong donating ability of this drug can be demonstrated by freezing an aqueous solution of chlorpromazine in Dry Ice in the presence of an equimolar riboflavin solution ($10^{-3}M$). On freezing, the solution turns greenish brown and loses all fluorescence—an expression of a complex formation.

Similarly, 1-methyl Medmain is a very good donor (highest filled electronic orbital, 0.348; lowest empty orbital, -0.869). The same is true for 1-benzyl-2-methyl-5-methoxy-(N, N-dimethyl)-tryptamine (highest filled level, 0.427; lowest empty level, -0.866,), which gives strongly colored complexes when frozen with flavin mononucleotide. The assumption that this color is actually due to the formation of a charge-transfer complex is supported by the spectrum. As has been shown earlier (*6*), the spectrum of the serotonin-flavin mononucleotide or of the tryptophan-flavin mononucleotide complex has a peak at 490 mμ, the wavelength characterizing the free radical of flavin mononucleotide at acid *p*H. Also, the chlorpromazine complex, when measured at $-78°C$ (*7*), shows a strong absorption at this wavelength; this indicates that the absorption is actually due to the flavin mononucleotide, which has accepted one electron. In addition, there is a broad absorption at 570 mμ. This peak may be tentatively identified as the absorption of the free radical of flavin mononucleotide at neutral *p*H (*8*). However, other possibilities suggest themselves. The peak may be due to the reverse of the usual charge transfer absorption, in which an electron moves from riboflavin back to chlorpromazine upon the absorption of a light quantum. A positive identification of the 570 mμ absorption must await future work.

If further experience bears out the assumption that the action of the drugs studied, as well as the action of other drugs with related effects, is due to charge transfer, then this may contribute to understanding of the mechanism of normal and abnormal psychic functions (*9*).

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References and Notes

1. L. Michaelis, "Fundamentals of oxidation and reduction," in *Currents in Biochemical Research* (Interscience, New York, 1946).
2. J. Weiss, *J. Chem. Soc.* **1942**, 245 (1942).
3. R. S. Mulliken, *J. Am. Chem. Soc.* **74**, 811 (1952).
4. For the meaning of K, see B. Pullman and A. Pullman, *Proc. Natl. Acad. Sci. U.S.* **44**, 1197 (1958).
5. B. Pullman and A. Pullman, *Biochim. et Biophys. Acta.*, in press.
6. I. Isenberg and A. Szent-Györgyi, *Proc. Natl. Acad. Sci. U.S.* **44**, 857 (1958).
7. For details of the measurements see I. Isenberg and A. Szent-Györgyi, *ibid.*, in press.
8. H. Beinert, *J. Am. Chem. Soc.* **78**, 5323 (1956).
9. This work was supported by grant No. H-2042 (C3) of the National Heart Institute and by grants from the Commonwealth Fund, the National Science Foundation, and the United Cerebral Palsy Associations. The energy levels were calculated with the aid of the Univac of the University of Pennsylvania, supported by the National Science Foundation. We are greatly indebted to B. Pullman and G. Berthier, both of the Sorbonne, University of Paris, France, for generously supplying their effective parameters. We wish to thank Smith, Kline and French Laboratories, Philadelphia, Pa., for samples of chlorpromazine-HCl, and Sandoz Chemical Works, Inc., of Hanover, N.J., for providing a supply of *d*-lysergic acid diethylamide.

22 June 1959

Microbial Fermentation in Certain Mammals

Abstract. The fermentation in the caecum and large intestine of ruminants is negligible compared with that in the rumen. In small ruminants the rate per unit contents is faster than in large ones, due to faster turnover. The cellulolytic bacteria of several ruminants are similar but differ in nutritional requirements.

A sojourn in Kenya to study microbial fermentation rates in the rumen of zebu and European cattle (*1*) also afforded an opportunity (*2*) to examine other mammals. Anaerobic culture tubes containing rumen fluid (or elephant caecal or colonic fluid) and cellulose agar (*3*) were prepared in the field, the contents of the appropriate organ of the freshly killed animal being used as part of the medium. The sterilized tubes were inoculated with serial dilutions of the fresh contents, and the medium was solidified and returned to the laboratory for incubation at 39°C. Characteristic clearing of the cellulose resembling that due to *Bacteroides succinogenes* from cattle (*3*) was observed in cultures from the eland, kongoni, zebu, and camel. A few colonies resembling *Butyrivibrio* (*4*) were also seen. In some culture series, noncellulolytic colonies were sufficiently visible that both total and cellulolytic colony counts could be made. The counts were similar in magnitude to those obtained in cattle by comparable methods (*5*). Data of the experiments are shown in Table 1.

Bacteroides succinogenes-like colonies from the kongoni and the eland, respectively, were inoculated into parallel culture tubes containing media prepared with sterile rumen fluid from the host or from a zebu. Difference in the diameter of the clearings developing in the thin cellulose agar showed that both bacterial strains grew faster with homologous than with zebu rumen fluid, though the difference for the kongoni was slight.

The contribution of each part of the

alimentary tract to the total microbial intestinal fermentation was also measured. The various organs were dissected out and weighed as soon as possible after the animal was killed (Table 2).

Samples of the fresh contents from the rumen, caecum, and colon were transferred as soon as possible to Warburg vessels, and the fermentation was measured manometrically (*1*, *6*). From the fermentation by the sample the total fermentation in each organ and the percentage contribution of each was calculated (Table 3). The rumen fermentation accounted for 95 to 98 percent of the total except in the male camel. Its rumen contained relatively little contents.

The proportion of methane varied between 11 and 24 percent of the total fermentation products. The range for caecal contents was 2 to 30 percent, for the colon, 3 to 26 percent. Its proportion tended to be relatively less in the smaller ruminants (gazelle and suni).

The fermentation rates per unit of rumen dry matter (Table 4) reflect the poor nutrition of the two camels and the zebus of experiment 29. The rate in the suni was the highest observed in any experiments.

Presumably acetic, propionic, and butyric acids were the chief acidic fermentation products, as in domestic ruminants (*7*). The nature of the fermentation products in the suni was of interest because of its very small size and its browsing habit. Direct chromatography (*8*) of 3 g of the suni rumen contents preserved in Bouin's fluid showed both butyric and propionic bands. Acetic acid was presumably present but was masked because the picric acid of the preservative moved in the column at the same rate as acetic acid.

The attempt to measure the fermentation in the elephant caecum and large intestine (experiment 50, Table 1) was unsuccessful, probably because the bicarbonate in the contents had been exhausted. These organs were quite inflated with gas at the time of sampling. Protozoa (thought to be *Elephantophilus zeta*) and numerous roundworms in the caecal contents were visible to the naked eye. The caecal contents were slightly acid to litmus paper; the colon contents were slightly alkaline. The inner surface of the wall of the caecum and about two feet of the colon wall were ridged and folded, presumably as an adaptation for absorption. The stomach contents were distinctly acid. Samples of the caecal and colon contents, removed after fermentation in those organs appeared to have ceased, showed *p*H's of 5.8 and 6.4, respectively, after transport to the laboratory. These values indicate that fermentation stopped before very low *p*H's were reached, as with incubated rumen contents from cattle on a hay ration.

The steady-state concentrations of fermentation products in the caecum and colon of the elephant of experiment 50 were as follows: large intestine, 14 μmole of butyric acid, 23 μmole of propionic acid, 91 μmole of acetic acid, and 6 μmole of formic acid. The kinds and amount of acids are similar to those often found in the bovine rumen.

If the energy requirements of mammals correspond approximately to the ¾ power of the weight, and if in ruminants the rumen fermentation supplies the major part of these requirements, the total fermentation in the smaller ruminants should be greater in proportion to their weight than in the larger ones. An increased total fermen-

Table 1. Culture counts of bacteria in the rumen of various wild and domesticated ruminants and in the caecum and large intestine of the elephant.

Host	Source	Colony count for cellulose digesters (No. /ml)	Total colony count, including noncellulolytics (No. /ml)
Zebu on grass hay	Ted Ledger, Muguga	2.4×10^8	
Grant's gazelle	Rift Valley, near Muguga	4×10^4	2×10^9
Thompson's gazelle	Rift Valley, near Muguga	2.3×10^6	4×10^8
Eland	Rift Valley, near Muguga	6×10^6	
Suni	Grounds at Muguga		1.3×10^9
Starving Zebu	Archer's Post	6×10^9	6×10^9
Starving Zebu	Archer's Post	4×10^7	
Female camel	Mr. Lowe, Archer's Post	4.1×10^8	
Male camel	Mr. Lowe, Archer's Post	8×10^6	
Fat-tailed hair-sheep	Muguga herd	2×10^6	2×10^8
Elephant caecum	Budongo Forest, Masindi	1×10^5	2×10^9
Elephant colon	Budongo Forest, Masindi	1×10^8	3×10^8

Table 2. Data on weights (in pounds, except when g is used to show grams) of contents in the rumen, caecum, and large intestine.

Animal and wt.	Rumen-reticulum			Caecum		Large intestine	
	Wt.	Ratio to body wt.	Dry wt. (%)	Wt.	Dry wt. (%)	Wt.	Dry wt. (%)
Zebu on fresh grass pasture (530)	80	.15	15.1	3	9.8	2	9.3
Grant's gazelle (108)	10	.09	18.0	68 g	22.9	286 g	17.8
Thompson's gazelle (53)	7	.13	23.9	112 g	18.0	242 g*	19.5
Eland (1143)	122	.11		6	15.1	8	16.1
Suni (3690 g)	290 g	.08	18.7	29 g	15.2	17 g	20.0
Starving Zebu	53		21.1	2	16.4	3	15.3
Starving Zebu	54		14.7	1.5	18.5	2.5	19.4
Camel, very thin, with trypanosomiasis (745)	124	.17	19.6	2	21.2	7.5	25.9
Camel, without food or water for 24 hr (1149)	115	.10	12.4	1.5	17.7	25	18.4
Elephant (3610)		.12†		220*		220*	
Elephant at Paraa (7937)		.11		264		610	
Elephant (2357)		.15		50		300	

* Estimated but not accurately weighed. † For elephants, ratio is of caecum and large intestine contents to body weight.

Table 3. Results of measurements on the fermentation in the rumen, caecum, and colon.

Animal	Fermentation products (mmole/hr)											
	Rumen				Caecum				Large intestine			
	Acid	CO_2	CH_4	% of total	Acid	CO_2	CH_4	% of total	Acid	CO_2	CH_4	% of total
Zebu on grass pasture	526	575	297	95.5	22.6	11.8	3.9	2.6	17.6	8.5	2.2	1.9
Grant's gazelle	70	91	24	97.9	0.67*		0.07	0.4	2.78*		0.34	1.7
Thompson's gazelle	32	60	16.0	97.8	1.14		0.022	1.1	1.23		0.035	1.1
Eland	800	978	488	98.1	20.1		5.3	1.1	15.1		3.45	0.8
Suni	16.2	11.3	3.5	97.4	0.39		0.044	1.4	0.32		.074	1.2
Starving Zebu No. 1	290*		73									
Starving Zebu No. 2	81	148	73									
Camel, very thin, with trypanosomiasis	343	487	164	96.5	7.1		1.7	0.8	23		4.6	2.7
Camel, without food or water for 24 hr	292	109	98	85.5	4.3		1.3	1.0	63		16.0	13.5

* Acid and CO_2 not separately determined.

tation (but slower fermentation per gram of dry matter) could result from retention of food in the rumen for a longer time, permitting more complete digestion. But longer retention necessitates a larger rumen and the rumen/body weight ratios in Table 1 do not indicate a greater ratio with decreasing body size.

The demand for extra energy in small ruminants could also be met by greater consumption of food. Increased food consumption, if not accompanied by an increase in rumen size, would cause faster turnover and a greater fermentation rate per unit of dry matter. The suni, the smallest ruminant studied, showed the greatest fermentation in relation to body weight, the greatest rate per unit of dry matter, and the smallest ratio of rumen contents to body weight. Apparently a greater turnover rate rather than a larger rumen volume accounts for the relatively higher yield of fermentation products. A greater digestibility of the food consumed could also be a factor. Observation of the suni rumen contents disclosed green seeds and foliage rather than grass.

A faster turnover in the small ruminants is also indicated by the lower percentage of methane in the total rumen fermentation products. In hay-fed zebu and European cattle (*1*) a lower percentage of methane is correlated with a higher fermentation rate and decreased retention time. On the assumption that this relationship also holds in wild ruminants, the low methane values indicate faster turnover.

Since more fermentable food would leave the rumen of animals having a rapid turnover, the fermentation in subsequent parts of the alimentary tract should be higher if the turnover rate is the only difference. The rate in the caecum and intestinal contents of the smaller animals is not higher (Table 4), suggesting that factors in addition to turnover affect the completeness of food utilization in the rumen.

From the relationships disclosed in these comparative studies it would be expected that in domestic ruminants with extra energy requirements, as in pregnancy and lactation, an increase in rumen turnover would be the chief means for satisfying the increased need. This would involve increased consumption, presumably through interaction with physiological and psychological factors which control appetite (*9*).

Table 4. Fermentation rates (mmole/hr per gram dry wt.).

Animal	Rumen	Caecum	Large intestine
Zebu	125	37	45
Grant's gazelle	233	45	58
Thompson's gazelle	142	42	42
Eland		53	32
Suni	629	79	64
Zebu No. 1	91		
Zebu No. 2	93		
Female camel	92	46	32
Male camel	59	69	56

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References and Notes

1. R. E. Hungate, G. D. Phillips, D. P. Hungate, A. McGregor, *J. Agr. Sci.*, in press.
2. We are indebted to Dr. D. Detray for assistance in collecting wild ruminants; to Dr. Lowe, veterinarian at Isiolo, for the camels; and to Dr. H. R. Binns, EAVRO, and the Nairobi Police Department for trucks and a portable electric generator.
3. R. E. Hungate, *Bacteriol. Rev.* **14**, 1 (1950).
4. M. P. Bryant and N. Small, *J. Bacteriol.* **72**, 16 (1956).
5. R. E. Hungate, *Can. J. Microbiol.* **3**, 289 (1957); M. P. Bryant and L. A. Burkey, *J. Dairy Sci.* **36**, 218 (1953).
6. R. E. Hungate, D. W. Fletcher, R. W. Dougherty, B. F. Barrentine, *Appl. Microbiol.* **3**, 161 (1955).
7. S. R. Elsden, M. W. S. Hitchcock, R. A. Marshall, A. T. Phillipson, *J. Exptl. Biol.* **23**, 191 (1946).
8. H. G. Wiseman and H. M. Irvin, *J. Agr. Food Chem.* **5**, 213 (1957).
9. This work was supported by a travel grant from the Rockefeller Foundation and by a grant in aid of research from the National Institutes of Health (E-1266) to one of us (R. E. H.).
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8 June 1959

Catalepsy in Two Common Marine Animals

Abstract. Two common marine animals of the South Atlantic and Gulf coasts, *Sicyonia brevirostris,* a penaeid shrimp, and *Opsanus beta,* a toadfish, may be induced to go into cataleptic states in the laboratory when they are threatened or molested. The behaviors of these two animals as they go into catalepsy are described. There is considerable paling in the fish but none in the shrimp.

Catalepsy is an interesting phenomenon which, aside from various fundamental physiological ramifications, may be of interest to surgeons and psychologists in the future in connection with anesthesia, hypnotism, and other matters. It may be defined as a state of bodily inactivity and rigidity in which the organism has an appearance very similar to that of a dead individual.

We have recently observed the cataleptic state in two common marine organisms. The observations seem to be of some intrinsic interest, besides possibly providing a basis for further experimentation.

The first case pertains to a fairly common shrimp, *Sicyonia brevirostris,* one of the so called "rock shrimp" of the family Penaeidae. This is a beautifully colored shrimp, basically white or cream-colored with splotches of pink and old rose on the legs and extremities and purple along the back. It belongs to the family which supports the largest American shrimp fishery, and it is to be found in offshore waters of the Atlantic and Gulf coasts of the United States and Mexico, from Virginia to Yucatan, out to depths of about 40 fathoms. This shrimp has a hard shell and is quite hardy, if kept in water of high salinity. There are other closely related species.

We have noted that when this shrimp is chased about an aquarium and caught by hand, it will go into a rigid state with the body arched concavely from the head to tail and with the legs and swimmerets drawn up tightly against the body. When released, the animal will fall through the water and come to rest on its side on the bottom, where it will lie for several seconds, up to a half minute. No preliminaries to this state have been observed, aside from the usual tail flipping which shrimp display when molested. This state is entered into very quickly, and probably no more than a second intervenes between the active state and the rigid one with the arched back, which is quite characteristic. No color change was noted.

A somewhat different behavior is presented by the toadfish *Opsanus beta,* of the Gulf coast of the United States. This fish is a cognate of *Opsanus tau* of the Atlantic coast, which, because of its large and easily obtainable egg, has become classic material in studies of the embryology of fishes. This species has also been utilized in many physiological studies because it lives in very shallow water and is easily obtainable; furthermore, it is an inactive, bottom fish. The toadfishes have also been studied by students of undersea noises, because of their well-known ability to produce little honking or beeping sounds. The toadfishes have no scales, and their coloring is generally a mottled brown.

We have noted that in the laboratory these fishes may be induced to go into a cataleptic state, but the process is not so simple as that described for the rock shrimp. At first the fish are induced fairly easily to go into catalepsy, but they become more and more recalcitrant as the process is repeated. Initially a fish might go into the cataleptic state when pursued by a few sweeps of the hand around the aquarium. After

several repetitions, however, it may become necessary to grab the fish and shake it, or, in short, threaten it with injury. We have tried several specimens —more than a dozen over a period of several weeks—and they all react in the same way. First the fish gives a honk, which from the subjective view sounds very sad. As one student said, "That fish says 'I've had it!'" Immediately thereafter the fins stiffen, the operculum distends to a maximum, and the gills themselves are seen to be widely separated from one another. All in all, the fish has the appearance of one which has been asphyxiated or has died out of the water. Then the fish begins to pale all over and rapidly loses its color, to such an extent that it becomes yellow. This state lasts from several seconds up to 2 or 3 minutes. Finally the fish gives a convulsive gasp and revives. The fish recovers its color slowly, and even for a period of several minutes to a half hour afterward, a fish which has undergone the cataleptic experience has a pale appearance.

It would be interesting to find out whether related shrimp and fishes of the same genus have similar behaviors. Various other interesting questions arise, such as the rate of heartbeat change, the possible connection of this state in the toadfish with the well-known ability of this fish to live in water of low oxygen content, and the cause of the color changes themselves. We have no plans to carry these studies further and wish to call attention to the fact that this material is available along most of the East Coast of the United States.

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9 July 1959

Spectrum of Venus in the Violet and Near-Ultraviolet

Abstract. Recent observations of the spectrum of the planet Venus, with spectrographs of low and high dispersion at the Georgetown College Observatory, show that a wide, continuous absorption band is present in the violet and near-ultraviolet. The band begins near wavelength 4500 A and extends to the short-wavelength limit of our spectrograms near 3800 A. It is similar in structure to the strong absorption, reported by others, for gaseous nitrogen tetroxide.

In his book on the planetary atmospheres Kuiper (*1*) suggests the need for further observations of their spectra in the ultraviolet. Recently we obtained, with the 1-prism Reiss spectrograph of the Georgetown College Observatory, a spectrogram of Venus that shows practically no spectrum on the short-wavelength side of the H and K lines. During the current season, with Venus as an evening star, we have secured additional observations confirming the earlier result.

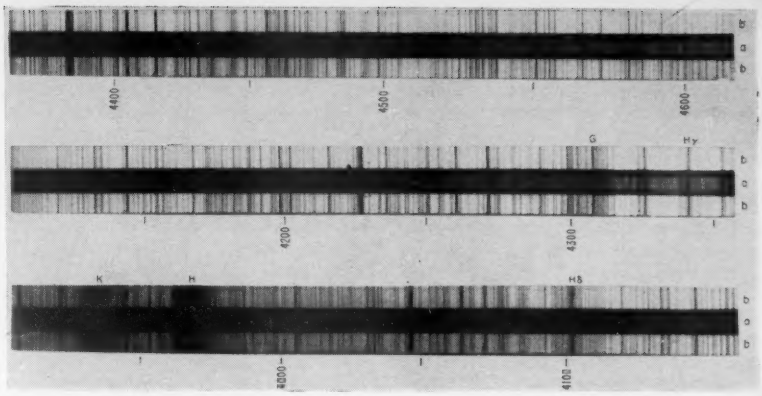

Fig. 1. High-dispersion spectra of Venus (*a*) and the Moon (*b*). Note the shift in spectra between the spectra due to the motions of Venus and the Moon relative to the Earth.

For the later observations we have used a concave grating of 21-ft radius. It was ruled with 30,000 lines per inch by the late H. G. Gale of the University of Chicago and is now the property of the National Geographic Society. It is set up in a Wadsworth mounting, at the Georgetown Observatory, and gives a dispersion, in the first order, that varies from 2.5 to 1.7 A/mm, according to the spectral region. With it an exposure of about 100 minutes is sufficient to record the spectrum of the planet, whereas an exposure of about 30 minutes is ample for the Moon when it is near full phase.

Figure 1 shows our results. The spectrum of Venus, beginning near 4500 A, declines steadily in intensity toward the H and K lines, beyond which little or no spectrum is visible to the short-wavelength limit of our plates near 3800 A. This is in agreement with Kozyrev's (*2*) observations at much lower dispersion, in which he reports a decrease in the albedo of Venus from 0.63 at 4600 A to 0.12 at 3800 A. However, there is no evidence on our spectrograms for the selective absorption that he reports at 4372 and 4120 A, nor do we find any evidence of selective absorption by the molecules suggested by Urey and Brewer (*3*) as probable sources of the absorptions reported by Kozyrev.

Part of the effect revealed by our spectrograms is attributable to loss of reflectance by the grating, as may be noted by comparison with the juxtaposed spectrum of the Moon. The general effect, however, is real and is similar to that observed in the spectrum of Jupiter by Kiess and Corliss (*4*) and reported by them to the American Astronomical Society at the recent meeting in Rochester, N.Y. This structureless, continuous absorption is practically identical with that described by several investigators, notably by Harris (*5*) and by Hall and Blacet (*6*) for nitrogen tetroxide, N_2O_4, the molecule polymerized at low temperatures from the molecule NO_2. The presence of this absorber in the atmospheres of Jupiter and Venus may thus account for the failure to detect molecular oxygen in them; and depending on conditions of temperature and pressure, it may account for the color effects. As may be seen from our illustration, the Doppler shift toward shorter wavelengths of the spectrum of Venus relative to that of the Moon is adequate to separate lines of planetary origin from their terrestrial counterparts, such as those of O_2 and H_2O; but no such lines, although sought, have been observed by us in the spectrum of Venus (*7*).

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Reference and Notes

1. G. P. Kuiper, *The Atmospheres of the Earth and Planets* (Univ. of Chicago Press, Chicago, Ill., 1949), p. 322.
2. N. A. Kozyrev, *Izvest. Krim. Astrofiz. Observatorila* **12**, 177 (1954).
3. H. C. Urey and A. W. Brewer, *Proc. Roy. Soc. (London)* **A241**, 37 (1957).
4. C. C. Kiess and C. H. Corliss, *Sci. News Letter* **75**, 229 (1959).
5. L. Harris, *Proc. Natl. Acad. Sci. U.S.* **14**, 690 (1928).
6. T. C. Hall, Jr., and F. E. Blacet, *J. Chem. Phys.* **20**, 1745 (1952).
7. This work was done with the support of contract No. DA-44-009-ENG-3578 through the U.S. Army Engineers at Fort Belvoir, Va.

27 July 1959

Association Affairs

Preview of Programs at AAAS Chicago Meeting

Some of the programs to be presented at the 1959 AAAS meeting in Chicago are given here. Others will be announced in subsequent issues. Further information can be found by referring to the following articles which have appeared in previous issues of *Science*: "Preliminary announcement of the Chicago meeting" [**129**, 1431 (22 May 1959)]; "Additional program notes, hotel headquarters, and housing for the Chicago meeting" [**130**, 226 (24 July 1959)]; "AAAS Chicago meetings, 1868–1959" [**130**, 923 (9 Oct. 1959)].

Mathematics

Section A. Vice-presidential address: "Topology of Euclidean Three-space," by R. H. Bing, University of Wisconsin. Symposium: "The New Look in Mathematical Education"; 27 Dec.; R. H. Bing, presiding. Papers will be presented on the work of the Committee on the Undergraduate Program (G. Baley Price, University of Kansas and California Institute of Technology); the ninth-grade course of the School Mathematics Study Group (Henry Swain, Winnetka, Ill.); new curriculum or new pedagogy (Morris Kline, New York University); early calculus in the United States (William L. Duren, Jr., University of Virginia).

Invited papers, cosponsored by the Society for Industrial and Applied Mathematics: "Trends in the Applications of Mathematics," arranged by Brockway McMillan, Bell Telephone Laboratories, with Mina Rees, Hunter College, presiding; 28 Dec. Introductory remarks (Mina Rees); random processes in control and communication (R. F. Drenick, Bell Telephone Laboratories); mathematical programming and the allocation of resources (Philip Wolfe, RAND Corporation); computers, computation and computer languages (Frank Wagner, North American Aviation, Inc.).

Association for Computing Machinery. Invited papers: "Today and Tomorrow in the World of Computers"; arranged by a committee, J. H. Wegstein, National Bureau of Standards, chairman; 29 Dec.; William F. Cahill, National Aeronautics and Space Administration, presiding. Papers: conversation with a machine (L. S. Green, KCS Limited, Toronto, and E. C. Berkeley, Berkeley Enterprises, Inc.); selective dissemination of new scientific information (H. P. Luhn, International Business Machines); stock brokerage accounting on a digital computer (Robert Joslyn, C-E-I-R, Inc.); an evaluation of Soviet computer efforts (John W. Carr, III, University of North Carolina).

Physics

Section B. Four-session symposium, cosponsored by Sigma Pi Sigma: "Recent Advances in Physics," arranged by J. Howard McMillen, National Science Foundation; 26, 28, and 29 Dec. Part I. Paper on high energy particles in the cosmic radiation (Marcel Schein, University of Chicago). Part II. Paper on the major unsolved problems of theoretical physics (Harold W. Lewis, University of Wisconsin). Part III. Papers on the progress and puzzles in nuclear structure (David R. Inglis, Argonne National Laboratory) and new ideas for accelerating multibillion-volt particles (Keith R. Symon, University of Wisconsin). Part IV. Papers on collisions between oriented atoms, photons, and thermal electrons (Richard H. Sands, University of Michigan) and filament optics (Walter L. Hyde, American Optical Company).

Physicists' luncheon and vice-presidential address of Section B (joint session with Sigma Pi Sigma and the Physics Club of Chicago): "Ethics and Thermodynamics," by Robert B. Lindsay, Brown University; 29 Dec.; Joseph C. Boyce, Illinois Institute of Technology, presiding.

Three symposia sponsored by Section L–History and Philosophy of Science which may be of interest to physicists are: "Empirical and Conventional Elements in Physical Theory," "The Logic of Variables and Constants," "Philosophical Issues of the Quantum Theory." Further details will be announced in a subsequent issue of *Science.*

Chemistry

Section C. Biochemistry Symposium: "Structure and Metabolism of Collagen"; 28 Dec.; arranged by Jerome Gross, Massachusetts General Hospital, who will preside. Papers will be presented on the structure of collagen (Alexander Rich, Massachusetts Institute of Technology); collagen-gelatin transition (Peter H. Von Hippel, Dartmouth College); unusual linkages in collagen (Paul M. Gallop, Albert Einstein College of Medicine); biosynthesis of collagen (David S. Jackson, University of Oregon Medical School); the collagen defect in vitamin C deficiency (William B. Van Robertson, University of Vermont); the collagen defect in lathyrism (Jerome Gross); immune reactions of collagen (Sidney Rothbard, Cornell University Medical College).

Organic Chemistry Symposium: "Some Recent Developments in Organic Chemistry"; 28 Dec.; S. Archer, Sterling-Winthrop Research Institute, presiding. Papers will be presented on organic chemical models of enzymatic hydrolysis (Myron L. Bender, Illinois Institute of Technology); practical procedures for the sodium-ammonia-alcohol reduction of aromatic compounds (Hugh L. Dryden, Jr., Gayle M. Webber, Robert R. Burtner, John A. Cella, of G. D. Searle and Company); mechanisms of proton transfer processes (Howard E. Zimmerman, Northwestern University); specific solvent effects in the alkylation of enolate anions (Harold E. Zaugg, Abbott Laboratories).

Inorganic and Nuclear Chemistry Symposium: "Some Recent Advances in Inorganic and Nuclear Chemistry"; 29 Dec.; J. J. Katz, Argonne National Laboratory, presiding. Papers will be presented on recent experimental studies of nuclear fission (John R. Huizenga, Argonne National Laboratory); current problems in mechanisms of complex reactions (Henry Taube, University of Chicago); rates and mechanisms by magnetic resonance (S. I. Weissman, Washington University).

Radiation Chemistry Symposium: "High-Energy Radiation Chemistry of Proteins and Amino Acids"; 29 Dec.; W. D. Bellamy, General Electric Research Laboratory, presiding. Introductory remarks (W. D. Bellamy); papers on physicochemical changes in irradiated proteins (Virgil L. Koenig, Northwestern University); chemical changes in irradiated proteins (D. M. Doty, University of Chicago); analytical

methods used in the study of irradiated proteins (C. Merritt, Jr., Quartermaster Research and Engineering Command, U.S. Army); irradiated amino acids (Charles Maxwell, National Institutes of Health).

On 30 Dec. there will be two sessions of submitted papers cosponsored by the Chicago Section, American Chemical Society. Edmund Field, Standard Oil Company of Indiana, will preside.

Section C will hold a reception for the speakers and a dinner for symposia chairmen and guests on 29 Dec.

American Association of Clinical Chemists. Symposium: "Diet, Serum Lipids, Lipid Metabolism, and Atherosclerosis"; arranged by Alvin Dubin, Cook County Hospital, Chicago, with Jeremiah Stamler, Heart Disease Control Program and Northwestern University School of Medicine, moderating: 27 Dec. Introductory remarks (Jeremiah Stamler); papers on the role of diet (J. T. Miller, Abbott Laboratories); influence of meal frequency and meal size (Clarence Cohn, Michael Reese Medical Center); role of immunological mechanism and lipoprotein lipase (Saul T. Baker, Chicago Medical School and Cook County Graduate School of Medicine); intermediary metabolism of cholesterol (Ivan D. Frantz, Jr., University of Minnesota Medical School).

Contributed papers will be presented 26 Dec., Chiadao Chen, Northwestern University Medical School, moderating, and 27 Dec., Martin E. Hanke, University of Chicago Medical School, moderating.

Astronomy

Section D. Symposium on the Solar System cosponsored by the American Astronautical Society: 26 Dec.; arranged by Gerard P. Kuiper, Yerkes Observatory, who will preside. Papers will be presented on meteorites and asteroids (Edward Anders, Enrico Fermi Institute); heat maps of the moon (William H. Sinton, Lowell Observatory); lunar cartography (D. W. G. Arthur, Yerkes Observatory); development of the lunar surface (Gerard P. Kuiper); thermal and non-thermal emission of planets (Frank D. Drake, National Radio Astronomy Observatory).

Symposium cosponsored by the Astronomical League: "Astronomical Photoelectric Photometry"; 26 Dec.; arranged by Arthur Code, Washburn Observatory, University of Wisconsin, who will preside. Papers will be presented on history and development of photoelectric technique; studies of variable stars and galactic structure by photoelectric methods; photoelectric photometry and amateur astronomy; future advances in photoelectric technique.

Astronomical League. Symposium: "Photoelectric Photometry"; arranged by Edward A. Halbach, Milwaukee Astronomical Society Observatory; papers will be presented on designing a good photoelectric photometer to meet the amateur's budget (Walter L. Moore, University of Louisville); flare of AD Leonis observed by photoelectric photometer (Donald Engelkemeir, Hinsdale, Ill.); photoelectric program of the AAVSO (John J. Ruiz, Dannemora, N.Y.).

Geology and Geography

Section E. Three-session symposium cosponsored by the Geological Society of America: "Quantitative Terrain Studies." Part I; arranged by Arthur N. Strahler, Columbia University, Jack R. Van Lopik, Warren E. Grabau, and Charles R. Kolb, U.S. Army Engineers Waterways Experiment Station, with Charles R. Kolb presiding. Papers will be presented on prediction in terrain analysis (Walter F. Wood, U.S. Army Quartermaster Research and Engineering Command); determination of the spatial relationships of locally dominant topographic features (Will F. Thompson, U.S. Army Quartermaster Research and Engineering Command); area sampling for terrain analysis (Louis Peltier, Midwest Research Institute, Kansas City); the technique of morphological mapping (R. A. G. Savigear, University of Sheffield, United Kingdom); possible gaussian components of zig-zag curves (W. F. Tanner, Florida State University); influence of scale in geomorphic map analysis (Donald R. Coates, Harpur College); characteristic and limiting slope angles (Anthony Young, Zomba, Nyasaland).

Part II; arranged by Howard A. Meyerhoff, Scientific Manpower Commission, and Charles R. Kolb, Warren E. Grabau, and Jack R. Van Lopik, U.S. Army Engineer Waterways Experiment Station, with Jack R. Van Lopik presiding. Papers will be presented on preliminary investigations of a method to predict line-of-sight capabilities (Joan B. Snell, U.S. Army Quartermaster Research and Engineering Command); terrain mask angles (A. Stein, Cornell Aeronautical Laboratory); classification and quantitative description of large geographic areas to define army transport system requirements (Seymour J. Deitchman, Cornell Aeronautical Laboratory); spectral reflectance data and its applicability to terrain studies by aerial photography (S. E. Swornik, C. N. Johnson, U.S. Army Engineer Research and Development Laboratories, J. C. Little and J. E. Walker, Broadview Research Corporation); radar as a terrain analyzing device (Allen M. Feder, Cornell Aeronautical Laboratory); objective field sampling of terrain properties (Arthur N. Strahler, Columbia University, and Donaldson Koons, Colby College); an instrumentation system for the measurement of stress-strain relationships of soil (I. J. Sattinger, University of Michigan).

Part III; arranged by Charles R. Kolb, Jack R. Van Lopik, and Warren E. Grabau, U.S. Army Engineer Waterways Experiment Station. Warren E. Grabau and Louis C. Peltier, Midwest Research Institute, Kansas City, presiding. Papers will be presented on weathering and geomorphic development (B. N. Rolfe, Sinclair Research Laboratories, Inc.); chemical degradation on opposite flanks of the Wind River Range, Wyoming (Charles H. Hembree and Frank H. Rainwater, U.S. Geological Survey); the value of landform analysis in studies of semiarid erosion (Stanley A. Schumm and R. F. Hadley, U.S. Geological Survey); use of recharge characteristics for quantitative analysis in geomorphology (Ward S. Motts, Roswell, N.M.); micro-relief-physiography-land use relationships (Stephen E. Dwornik, Philip K. Webb and Jack R. MacCormac, U.S. Army Engineer Research and Development Laboratories); average slope and agricultural productivity in Ohio (Woodford M. Garrigus, East Carolina College).

Three-session symposium, cosponsored by Section M–Engineering, the Geological Society of America, The American Geophysical Union, and The Association of American Geographers: "Great Lakes Basin"; arranged by George B. Maxey, Illinois State Geological Survey, and Jack L. Hough, University of Illinois; 29 and 30 Dec. Part I, George B. Maxey and Jack L. Hough, presiding. Introduction (George B. Maxey); Papers on geologic framework of the Great Lakes Basin (Jack L. Hough); physiography, topography, and watershed characteristics of the Great Lakes Basin (William Powers, Northwestern University); the water balance of the Great Lakes system (G. K. Rodgers, Ontario Department of Lands and Forests, and J. P. Bruce, Canada Department of Transport); lake waters—circulation and physical and chemical characteristics (John C. Ayers, Great Lakes Research Institute, University of Michigan); regimen of the Great Lakes and fluctuations of lake level (William T. Laidly, U.S. Lake Survey, Corps of Engineers); recession of Great Lakes shorelines (Howard J. Pincus, Ohio State University). Open discussion by members of the panel.

Part II, Albert G. Ballert, Great Lakes Commission, and John C. Ayers, University of Michigan, presiding. Pa-

pers will be presented on economic geography: mineral, agricultural, and industrial resources development (Albert G. Ballert); the land use pattern (Andrew H. Clark, University of Wisconsin); development of the transportation network (Carl W. Muhlenbruch and Robert C. Stuart, Educational and Technical Consultants, Inc.); navigation on the Great Lakes (Edwin W. Nelson, U.S. Corps of Engineers); hydroelectric power in the Great Lakes–St. Lawrence Basin (Kenneth G. Tower, Federal Power Commission); utilization of water in the Great Lakes Basin: recreation (Stanley A. Cain, University of Michigan); the nature of use and consumption of Great Lakes water for domestic and industrial purposes (Merril B. Gamet, Northwestern Technological Institute).

Part III, Howard J. Pincus, Ohio State University, and M. B. Gamet, Northwestern Technological Institute, presiding. Papers will be presented on ground-water supplies in Wisconsin and Illinois adjacent to Lake Michigan (Robert E. Bergstrom, Illinois State Geological Survey, and George F. Hanson, Wisconsin Geological and Natural History Survey); surface and ground-water supplies in Ontario (A.K. Watt, Ontario Water Resources Commission); surface and ground-water supplies in Lake Michigan Drainage Basin in Indiana (Claude Roberts, U.S. Geological Survey); water pollution in the Great Lakes (Arve Dahl, U.S. Public Health Service); beach engineering and harbor protection (R. O. Eaton, Beach Erosion Board); more fruitful use of Great Lakes water through legislation, investigation, and cooperation (H. W. Poston, U.S. Public Health Service). Open discussion by members of the panel. Summary (George B. Maxey).

Section E smoker and vice presidential address, cosponsored by the Geological Society of America and the Association of American Geographers: "Role of Subsidence in the Origin and Evolution of the Appalachian Mountains," by Byron N. Cooper, Virginia Polytechnic Institute; 29 Dec.; Howard A. Meyerhoff, presiding.

Association of American Geographers. Symposium: "The Geographer's Role in Transportation Studies"; 29 Dec.; arranged by Alden Cutshall, University of Illinois; Edward Taaffe, Northwestern University, presiding. Papers will be presented on the history, purpose, and scope of a transportation study (E. Wilson Campbell, Chicago Area Transportation Study); land use and floor inventory (Robert Sharkey, Chicago Area Transportation Study); land use and travel forecast (John R. Hamburg, Chicago Area Transportation Study); maps and graphics as a mode of analysis for planning (Garred Jones, Chicago Area Transportation Study); summary comments (Edward Taaffe).

Symposium: "Southwest Asia and North Africa"; 29 Dec.; Alden Cutshall, chairman. Papers will be presented on animal life and continuity of environment in the late Quaternary in northern Iraq (Charles Reed, University of Illinois); late Pleistocene glaciation in Southwest Asia (Herbert E. Wright, Jr., University of Minnesota); man-made environmental changes in the historical period of North Africa (Marvin Mikesell, University of Chicago); chronology and implications of fossil soils in the terraces of the Nile Valley (Karl W. Butzer, University of Wisconsin).

Illinois Geographical Society. Symposium, cosponsored by the Association of American Geographers: "Economic Changes in Underdeveloped Areas"; arranged by Mary Grant, Morton Junior College; 28 Dec.; Dalias Price, Eastern Illinois University, presiding. Papers will be presented on some recent changes in the economy of Egypt, United Arab Republic (Floyd F. Cunningham, Southern Illinois University); post-war economic changes in Nigeria (Robert O. Johnsrud, Northwestern University); some new developments in Thailand's economy (Helen L. Smith, Wheaton College); patterns and progress in the Philippines (Alden D. Cutshall); economic changes in the region of Brazil's new capital (Robert L. Carmin, University of Illinois).

National Geographic Society. Lecture and color film, "Dzibilchaltun: Lost City of the Maya," by E. Wyllys Andrews, leader of the National Geographic Society–Tulane University Expedition; 30 Dec.

National Speleological Society. Two-session symposium cosponsored by the Society of Systematic Zoology: "Speciation and Raciation in Cavernicoles"; Thomas C. Barr, Jr., Tennessee Polytechnic Institute, chairman; 28 Dec. Part I. Papers on speciation in North American cave planarians (Libbie H. Hyman, American Museum of Natural History); the origins and affinities of the cave crayfishes of North America (Horton H. Hobbs, Jr., University of Virginia); speciation in cave opiliones (Clarence J. Goodnight, Purdue University); sequential development of cave adaptation in the Amblyopsidae (Thomas L. Poulson, University of Michigan).

Part II. Papers on evolution in cave entomobryinae (Kenneth Christiansen, Grinnell College); the manner and time of dispersal of cavernicolous beetles (Carl H. Krekeler, Valparaiso University); Texas cave beetles of the genus *Rhadine* (Thomas C. Barr, Jr., Tennessee Polytechnic Institute); speciation in American cavernicolous pselaphid beetles (Orlando Park, Northwestern University).

Symposium, cosponsored by the Geological Society of America: "Origin and Development of Limestone Caverns"; 28 Dec.; George W. Moore, U.S. Geological Survey, presiding. Papers will be presented on origin of caves in folded limestone (William E. Davies, U.S. Geological Survey); origin of Bermuda caves (J Harlen Bretz, University of Chicago); changing concepts of speleogenesis (William R. Halliday, Western Speleological Survey); origin and geologic relations of Breathing Cave, Virginia (George H. Deike, III, University of Missouri); terminations of passages in Appalachian caves as evidence for a shallow-phreatic origin (William B. White, Pennsylvania State University); stochastic models of cavern development (Rane L. Curl, Shell Development Company); geometric basis for cave interpretation (Arthur L. Lange, Cave Research Associates).

Those in the physical sciences will be particularly interested in the AAAS General Symposium. One of the speakers on the evening of 26 Dec. will be William H. Pickering, Director, Jet Propulsion Laboratory, California Institute of Technology, who will speak on "How artificial satellites can help scientific research." Another speaker will be Robert E. Marshak, chairman of the Department of Physics and Astronomy, University of Rochester, who will speak on "Elementary particles of modern physics."

Forthcoming Events

November

27–17. Bahamas Medical Conf. Nassau. (B. L. Frank, Box 4037, Fort Lauderdale, Fla.)

29–30. American College of Chest Physicians, Dallas, Tex. (M. Kornfield, 112 E. Chestnut St., Chicago 11, Ill.)

29–4. American Soc. of Mechanical Engineers, annual, Atlantic City, N.J. (ASME, 29 W. 39 St., New York 18.)

30–2. American Acad. for Cerebral Palsy, 13th annual, Los Angeles, Calif. (G. L. Brooks, AACP, Brown Univ., Providence 12, R.I.)

30–2. French-Speaking Neurosurgeons Society, annual, Paris, France. (M. David, 4, rue Galliera, Paris.)

30–3. Eastern Joint Computer Conf., Boston, Mass. (Miss M. Fox, EJCC, Box 4999, Washington 8.)

30–3. Entomological Soc. of America (joint with the societies of Canada and Ontario), annual, Detroit, Mich. (L. L. Reed, Entomological Soc. of Canada, Science Service Building, Ottawa, Canada.)

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Chicago, 26-31 December 1959

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30–16. Tropical Meteorology, symp., Nairobi, Kenya, East Africa. (Secretariat, World Meteorological Organization, Campagne Rigot, Avenue de la Paix, Geneva, Switzerland.)

30–17. Problems of Tropical Meteorology in Africa and the Neighboring Islands, symp., Nairobi, Kenya, Africa. (World Meteorological Organization, Campagne Rigot, 1, Avenue de la Paix, Geneva, Switzerland.)

December

1–3. Eastern Joint Computer Conf., Boston, Mass. (D. T. Ross, Dept. of Electrical Engineering, Massachusetts Inst. of Technology, Cambridge.)

1–4. American Medical Assoc. (clinical), Dallas, Tex. (R. M. McKeown, 510 Hall Bldg, Coos Bay, Oreg.)

2–4. Electrical Furnace Conf., Cleveland, Ohio. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

3–4. Semiconductor Surfaces, 2nd conf., Silver Spring, Md. (R. F. Greene, U.S. Naval Ordnance Lab., White Oak, Silver Spring, Md.)

3–4. Vehicular Communications, St. Petersburg, Fla. (L. G. Cumming, IRE, 1 E. 79 St., New York 21.)

3–5. Corrosion, symp., Dresden, Germany. (Chemische Gesellschaft in der Deutschen Demokratischen Republik, Unter den Linden 68/70, Berlin W.8, Germany.)

3–5. Visual Communications, 3rd annual intern. conf., New York, N.Y. (E. Kaestner, Soc. of Reproductive Engineers, Bell Telephone Labs., New York, N.Y.)

3–11. Training and Education in Nutrition, European symp., Frankfurt am Main, Germany. (Food and Agricultural Organization of the United Nations, Viale delle Terme di Caracalla, Rome, Italy.)

3–12. International Confederation of Free Trade Unions, 7th world cong., Brussels, Belgium. (ICFTU, 24, rue du Lombard, Brussels.)

4–6. American Psychoanalytic Assoc., New York, N.Y. (D. Beres, 151 Central Park West, New York 23.)

5–10. American Acad. of Dermatology and Syphilology, Chicago, Ill. (R. R. Kierland, First National Bank Bldg., Rochester, Minn.)

6. American Acad. of Dental Medicine, mid-annual, New York, N.Y. (A. J. Cannistraci, 2152 Muliner Ave., New York 62.)

6–10. American Inst. of Chemical Engineers, annual, San Francisco, Calif. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36.)

7–12. Algology, UNESCO symp., New Delhi, India. (J. P. Correa, South Asia Cooperation Office, 21, Curzon Rd., New Delhi, India.)

8–10. Application of Electrical Insulation, 2nd natl. conf., Washington, D.C.) (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

9–15. American Acad. of Optometry, Chicago, Ill. (C. C. Koch, 1506–1508 Foshay Tower, Minneapolis 2, Minn.)

11–12. American Rheumatism Assoc., Detroit, Mich. (F. E. Demartini, Presbyterian Hospital, 622 W. 168 St., New York 32.)

11–12. Association for Research in

Nervous and Mental Disease, annual, New York, N.Y. (R. J. Masselink, 700 W. 168 St., New York 32.)

25–27. Indian Mathematical Soc., 25th conf., Allahabad, India. (B. N. Prasad, Allahabad Univ., Lakshmi Niwas, George Town, Allahabad 2.)

26–30. American Assoc. for the Advancement of Science, annual, Chicago, Ill. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., N.W, Washington 5.)

The following 46 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Committee on Science and the Promotion of Human Welfare (B. Commoner, School of Botany, Washington Univ., St. Louis 5, Mo.). 27 Dec.

AAAS Cooperative Committee on the Teaching of Science and Mathematics (Brother G. Nicholas, Dept. of Biology, Univ. of Notre Dame, Notre Dame, Ind.). 27 Dec.

Academy Conference (A. M. Winchester, Stetson Univ., De Land, Fla.). 27–28 Dec.

Alpha Epsilon Delta (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.). 29 Dec.

American Assoc. of Clinical Chemists (A. Dubin, Director of Biochemistry, Cook County Hospital, Chicago 12, Ill.). 26–27 Dec.

American Geophysical Union (W. C. Krumbein, Dept. of Geology, Northwestern Univ., Evanston, Ill.). 28 Dec.

American Meteorological Soc. (K. Spengler, 3 Joy St., Boston, Mass.).

American Nature Study Soc. (E. L. Will, State Univ. Teachers College, Oneonta, N.Y.). 26–30 Dec.

American Physiological Assoc. (F. A. Hitchcock, Ohio State Univ., Columbus). 28 Dec.

American Political Science Assoc. (J. Robinson, Dept. of Political Science, Northwestern Univ., Evanston, Ill.). 28 Dec.

American Psychiatric Assoc. (E. L. Bliss, General Hospital, Salt Lake City, Utah). 28–29 Dec.

American Soc. of Criminology (D. E. J. MacNamara, New York Inst. of Criminology, Inc., New York 36). 28–29 Dec.

American Soc. of Naturalists (A. D. Hasler, Dept. of Zoology, Univ. of Wisconsin, Madison). 27–28 Dec.

American Soc. of Plant Taxonomists (L. R. Heckard, Dept. of Botany, Univ. of Illinois, Urbana). 28–30 Dec.

American Sociological Soc. (J. S. Coleman, Dept. of Sociology, Univ. of Chicago, Chicago 37, Ill.). 28–29 Dec.

American Statistical Assoc. (R. F. Winch, Dept. of Sociology, Northwestern Univ., Evanston, Ill.). 29–30 Dec.

Association of American Geographers (A. Cutshall, Univ. of Illinois, Navy Pier, Chicago 11). 29 Dec.

Association for Computing Machinery (W. F. Cahill, Goddard Space Flight Center, Silver Spring, Md.). 29 Dec.

Astronomical League (E. Halbach, 2971 S. 52 St., Milwaukee 19, Wisc.). 26 Dec.

Beta Beta Beta (Mrs. F. G. Brooks, P.O. Box 515, Ansonia Station, New York 23). 27–28 Dec.

Chicago Acad. of Sciences (R. A. Edgren, Chicago Acad. of Sciences, 2001 N. Clark St., Chicago 14, Ill.). 29–30 Dec.

Conference on Scientific Communications (G. L. Seielstad, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.). 28–29 Dec.

Conference on Scientific Manpower (T. J. Mills, National Science Foundation, Washington 25). 28 Dec.

Ecological Soc. of America (W. C. Ashby, Dept. of Botany, Univ. of Chicago, Chicago 37, Ill.). 28–30 Dec.

Honor Soc. of Phi Kappa Phi (L. R. Guild, 634 S. Western Ave., Los Angeles 5, Calif.). 30–31 Dec.

Illinois Geographical Soc. (Miss M. Grant, Morton Junior College, Cicero, Ill.). 28 Dec.

Institute of Management Sciences (M. M. Flood, College of Engineering, Univ. of Michigan, Ann Arbor). 29 Dec.

Metric Assoc. (J. T. Johnson, Ravenswood YMCA, 1725 Wilson Ave., Chicago 40, Ill.).

Mycological Soc. of America (D. P. Rogers, Dept. of Botany, Univ. of Illinois, Urbana).

National Assoc. of Biology Teachers (H. E. Weaver, 202 Men's Old Gym, Univ. of Illinois, Urbana). 26–30 Dec.

National Acad. of Economics and Political Science (J. Rothrock, Pan American Union, Washington 6). 29 Dec.

National Assoc. for Research in Science Teaching (J. C. Mayfield, Univ. of Chicago, Chicago 37, Ill.). 26–30 Dec.

National Assoc. of Science Writers (P. Fraley, Evening Bulletin, Philadelphia, Pa.). 27 Dec.

National Geographic Soc. (W. R. Gray, NGS, 16 and M Sts., NW, Washington 6). 30 Dec.

National Science Teachers Assoc. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington, D.C.). 26–30 Dec.

National Soc. for Medical Research (R. A. Rohweder, NSMR, 920 S. Michigan Blvd., Chicago 5, Ill.). 29 Dec.

National Speleological Soc. (T. C. Barr, Jr., Tennessee Polytechnic Inst., Cookeville, Tenn.). 28 Dec.

Philosophy of Science Assoc. (W. A. R. Ley, Roosevelt College, Chicago, Ill.). 28 Dec.

Scientific Research Soc. of America (D. B. Prentice, 56 Hillhouse Ave., New Haven 11, Conn.). 29 Dec.

Sigma Delta Epsilon (Miss E. S. Anderson, Stratford Hotel, 25 E St., NW, Washington, D.C.). 26–30 Dec.

Society for General Systems Research (R. L. Meier, Mental Health Research Institute, Univ. of Michigan, Ann Arbor).

Society for the History of Technology (M. Kronzberg, Dept. of History, Case Inst. of Technology, Cleveland, Ohio).

Society of the Sigma Xi (T. T. Holme, 56 Hillhouse Ave., New Haven 11, Conn.). 29 Dec.

Society of Systematic Zoology (R. E. Blackwelder, Southern Illinois Univ., Carbondale). 26–30 Dec.

Tau Beta Pi Assoc. (R. H. Nagel, Univ. of Tennessee, Knoxville). 27 Dec.

United Chapters of Phi Beta Kappa (C. Billman, 1811 Q St., NW, Washington, D.C.). 29 Dec.

(See issue of 16 October for comprehensive list)

GRASSLANDS

Editor: Howard B. Sprague **1959**

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Wherever hazardous lab atmospheres exist, you can safely blend materials at high speed—even on your toughest research and development projects. This new Waring Laboratory Blendor provides the protection of a 1/5 hp explosion-proof GE motor which carries a Class 1—Group D rating. Two speed explosion-proof switch also available.

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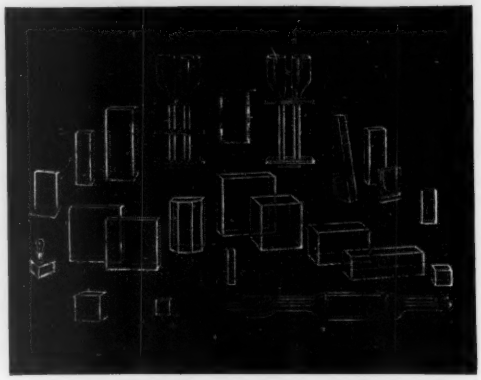

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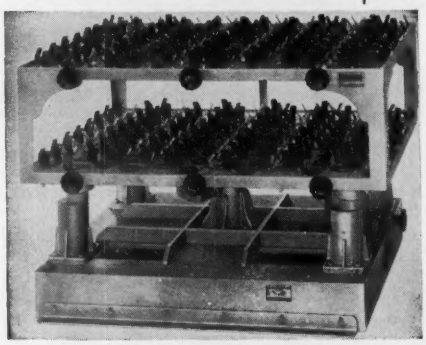

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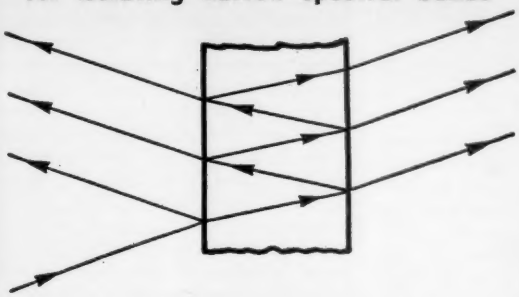

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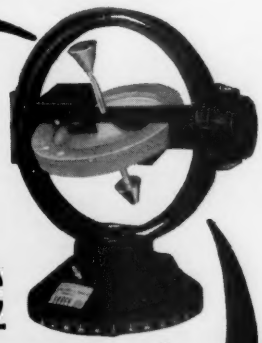

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WARING BLENDOR®

(MODEL CB-4)

WITH NEW POWER AND EXTRAORDINARY PERFORMANCE

Greater motor power, torque and amperage, plus an increased RPM range make Waring's newest, large capacity Blendor more valuable than ever in the lab. It does hundreds of diverse mixing, grinding and blending jobs with liquids or solids. Examples: macerating plant material, pulping wood fibers, mixing heavy paint pigments, and preparing dispersions, emulsions, polymers and slurries. *And most operations take only seconds!* Of special importance is the fact that this improved CB-4 model *will not overheat* over prolonged periods of use.

NAME YOUR BLENDING PROBLEM.
Waring engineers will gladly help you solve it.

CHECK THESE ADVANTAGEOUS SPECIFICATIONS:

Mixing capacity: One full gallon.

Revolutions per minute: (free running) low 14,000; medium 17,000; high 19,000.

Motor: 115 volts—60 cycles—single phase—AC only—15 amps.

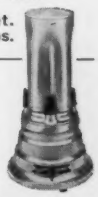
Switch settings: Off, Low, Medium, High.

Container: Stainless steel with stainless steel blades and handle—two-piece clamp-on splash cover with sealing gasket and stainless steel cover for sampling and adding ingredients.

Cord: 7 foot—14 gauge. Three conductor ground cord with strain relief bushing in base.

Overall height: 23 inches.

Weight: 36 lbs. net. Shipping weight 40 lbs.



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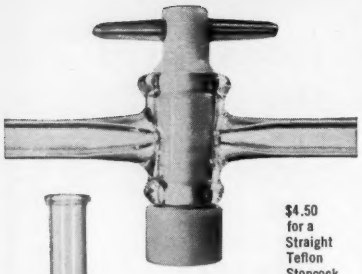

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New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science *nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to* Science, *Room 740, 11 West 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).*

■ STANDING-WAVE INDICATOR for measurement of voltage-standing-wave ratio and reflection-coefficient angle operates by means of a probe rotating in the plane of circular polarization of a waveguide. A low-power broad-band model is designed for laboratory applications; a high-power, 12-percent bandwidth unit operates in the kilowatt and megawatt ranges. Insertion length is 10 in. (Polytechnic Research and Development Co., Dept. 155)

■ MICRODOSIMETER SYSTEM, for measurement of x-ray and γ radiation, is composed of a detector and a reader. The detector is a cylindrical rod, 1 by 6 mm, of silver-activated phosphate glass. The reader is a special fluorimeter designed to measure change in fluorescence caused in the detector rods by high-energy radiation. Range is 10 to 10,000 rad. (Bausch & Lomb Optical Co., Dept. 171)

■ VOLTMETER measures a-c or d-c voltages from 1 mv to 1000 v (full scale) in 14 ranges, and resistance from 10 ohm to 10 megohm in 7 decade ranges. Accuracy is said to be better than ± 1 percent on direct current; ± 2 percent from 20 cy to 100 kcy/sec; and ± 5 percent from 10 cy to 1 Mcy/sec. A scale-expansion feature permits the upper 10 percent or 1 percent d-c voltage to cover the full meter scale. (Southwestern Industrial Electronics Co., Dept. 175)

■ AIR OPERATED PUMP, for application where electrical power is not available or where its use is undesirable, develops liquid pressures up to 50,000 lb/in.^{2} (gage) at temperatures up to 500°F. Operation requires air at a maximum pressure of 100 lb/in.^{2} (gage). Suction as well as pressure is provided. Various packings are available. (American Instrument Co., Dept. 170)

■ REFRIGERATOR-FILTER is designed to safeguard pneumatically operated equipment, in locations where cooling water is not available, by removing moisture, oil, and contaminants. The unit lowers dewpoint to approximately 35°F at pressure. Condensed moisture and other entrained liquids are removed by filter. Capacity is 100 standard ft^3/min at 100 lb/in.^{2} (gage) and 100°F. (Hankison Corp., Dept. 185)

■ CONTROLLED RECTIFIER is a three-junction silicon device capable of switching rapidly (in the order of microseconds) to a conducting state either when a signal is applied to its third (gate) terminal or when its critical forward breakover voltage is exceeded. After firing, the device exhibits forward voltage drop of approximately 1.5 volts at 25°C. Current ratings are up to 10 amp (av.), and inverse-voltage ratings range from 20 to 200 volts. Leakage currents are 12 ma in both directions. (International Rectifier Corp., Dept. 180)

■ PLASTIC DEFLECTION TESTER indicates deflection of thermoplastics subjected to various loads and temperatures in accordance with ASTM test D648-56. Four samples can be tested simultaneously, deflection being indicated on dials mounted on the specimen holders. Bath temperature can be increased at a rate of 2°C/min from ambient temperature to 260°C, or it can be maintained constant at any point in this range. (American Instrument Co., Dept. 176)

■ SAMPLE CHANGER for assay of radioactive samples in liquid solution accommodates 50, 5-ml glass or plastic sample vials in a circular turntable. Samples are grasped for transport by a magnet acting on nickel-plated steel vial caps. The sample is automatically inserted into the well of a shielded scintillation detector, counted, and removed to a storage rack. Cycling may be continuous or may be terminated after one, two, or three cycles. (Tracerlab-Keleket, Dept. 177)

■ DIGITAL TRANSDUCER for process variables employs a mechanical force amplifier, actuated by standard measuring elements, to position the shaft of an analog-to-digital converter. Instruments are available for pressure ranges to 10,000 lb/in.^{2}, temperature to 600°F, and with mercury- or bellows-type manometers for applications to liquid level or flow. Accuracy is said to be ± 1.0 percent of span. (American Meter Co., Dept. 179)

■ SERVOANALYZER covers the frequency range 0.25 to 100 cy/sec in one model and 0.0008 to 100 cy/sec in another. Frequency stability is ± 1.0 percent. Output waveforms include sine wave (20 volts peak-to-peak); modulated sine wave; square wave (20 volts peak-to-peak); trigger pulse. The cathode-follower output is provided with a 100-to-1 attenuator. Phase is measured ± 180 deg. An internal carrier source furnishes 5000 cy/sec. (Aetna Electronics Corp., Dept. 184)

JOSHUA STERN

National Bureau of Standards, Washington, D.C.

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Replies to blind ads should be addressed as follows:
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Washington 5, D.C.

POSITIONS WANTED

Pharmacologist-Physiologist, married, M.A., Ph.D., M.D., certified in internal medicine; age 44; numerous publications in general field of cardio-vascular mechanisms and drug action. Would like opportunity to set up department in medical university and also continue investigation program. Broad teaching experience. Box 229, SCIENCE. 10/30; 11/13

(a) **Ph.D.,** microbiology major; biochemistry minor; public health and food bacteriology experience; (b) **Young Biochemist,** M.S. degree from leading university; 2 years' experience with fermentation procedures and enzyme isolations with pharmaceutical firm; prefers research and development appointment. Medical Bureau, Inc., Burneice Larson, President, 900 North Michigan, Chicago. X

Ph.D., Entomologist-Ecologist desires research position. Broad background with 10 years' experience in various phases of entomology. Box 242, SCIENCE. X

POSITIONS OPEN

Analytical Chemist. Position in pharmaceutical research control group for company producing ethical line of veterinary pharmaceutical and biological products. Duties include control of and assisting in the development of new control procedures for pharmaceutical products produced by the company. Excellent growth opportunity for qualified man possessing B.S. degree in chemistry. Contact Personnel Manager, Jensen-Salsbery Laboratories, Inc. (a subsidiary of Vick Chemical Company), 21st and Penn, Kansas City 41, Missouri. 10/30; 11/6

Assistant Clinical Chemist. Masters' degree in biochemistry or bachelor's degree in chemistry plus experience. Will assist in supervision of clinical chemistry laboratory, performance of special tests, and teaching of students. Accredited 400-bed hospital, large eastern city. Box 240, SCIENCE. 11/6, 13

(a) **Bacteriologist;** requires minimum 5 years' experience; head department, 300-bed voluntary general hospital; supervise microbiology, some teaching; California coastal resort city. (b) **Biochemst;** head department, 300-bed university-affiliated general hospital; midwestern capital city. (c) **Assistant Chemist;** M.S. preferred to work with Ph.D. director, perform complicated tests, some teaching, research responsibilities; very large general hospital affiliated outstanding group diagnosticians; to $6600; mideastern college city. (d) **Pharmacologist;** Ph.D. pharmacology experienced experimental pharmacodynamics, capable independent gynecological research; to $11,000; eastern concern. Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash Avenue, Chicago. X

Biologist, Histologist, Histochemist, Ph.D. or equivalent. Research institute, New York, to work in the field of experimental diabetes. Box 235, SCIENCE. 10/30; 11/6

POSITIONS OPEN

Bacteriologist Technician. Opportunity for technician in clinical medicine research for an ethical company producing pharmaceutical and biological products. Position involves testing and aiding in the development of new products in cooperation with the research veterinarians. Good growth potential for man with B.S. degree in bacteriology. Contact Personnel Manager, Jensen-Salsbery Laboratories, Inc. (a subsidiary of Vick Chemical Company), 21st and Penn, Kansas City 41, Missouri. 10/30; 11/6

CLINICAL RESEARCH

Prominent Eastern pharmaceutical company desires young M.D. — preferably board eligible in Internal Medicine or Psychiatry — capable of establishing and monitoring programs in therapeutic research. This position represents a unique opportunity for creativity and personal growth within the specialty. Additionally, it provides ample opportunities for travel to important conferences and academic centers and for association with outstanding authorities.

Ideal suburban living and working conditions, excellent salary and benefits. Our staff is aware of this advertisement.

Send curriculum vitae to

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Herbicides Biologist; Ph.D. (0 to 5 years' experience) to be project leader of laboratory devoted to plant growth-regulatory research with primary emphasis on screening and evaluating for new herbicides. Plant physiology and/or agronomy are desirable major disciplines with biochemistry and morphology as minors. Write Research Director, Niagara Chemical Division, Middleport, New York, for application for employment blank. eow

Bacteriologist. Visiting professor to teach graduate course in microbial physiology at Louisiana State University, spring, 1960. Ample salary, air-conditioned building. Apply Dr. C. S. McCleskey, Bacteriology, Louisiana State University, Baton Rouge. 10/30

Biologist. Replacement for staff member for 1 year beginning July 1960 at small liberal arts college on Northeast coast. To teach comparative anatomy, histology, embryology—each for one term. Box 238, SCIENCE. X

CHEMIST— ORGANIC

Well-known Philadelphia pharmaceutical manufacturer seeks individual with M.S. or equivalent with interest in or experience with National Products (principally alkaloids) and the inter-relationships of chemistry, botany and pharmacology. Evaluation of literature and laboratory data, close scientific contact with other members of team and organization, as well as foreign and domestic investigators. Good written and oral English; foreign language not necessary but helpful. Liberal benefit program. Send complete resume.

BOX 233, SCIENCE

Electron Microscopist, Ph.D. or equivalent. Research institute, New York, modern well-equipped and staffed air-conditioned laboratory. Must have adequate training and experience in all phases of preparation of tissues and in handling machine. Apply Box 231, SCIENCE. 10/23; 30

New World-Wide Graduate Award Directories for American scientists, teachers, librarians to subsidize their education and research. Stipends $200—$10,000. Volume I (1957), $3; volume II (just published, no duplication), $3; both volumes, $5. Limited editions. Complete, specific information on 400 awards in United States and overseas in each volume. CRUSADE, Sci., Box 99, Station G, Brooklyn 22, N.Y. eow

Jensen-Salsbery Laboratories, Inc., manufacturer of pharmaceutical and biological products, offers two new appointments:

1. **Bacteriologist or Virologist**
   Applications are invited from microbiologists with laboratory experience in bacteriology or virology. Requirements are a master's degree or doctorate in a microbiological science and several years' laboratory experience. Experience in immunology and concerntration of blood protein factor is desirable but not essential. The successful applicant would assist in supervising the manufacture of immunological products and also carry out research and development work on existing and new products.

2. **Microbiologist (Tissue Culture)**
   Graduates in microbiology are invited to apply for a position in the tissue culture laboratory. Applicants should possess a degree in bacteriology or other biological science and have postgraduate experience in microbiology. Experience in tissue culture techniques is desirable but not essential. The successful applicant would assist in the manufacture of tissue culture virus products and the development of new virus and other vaccines prepared in tissue culture systems.

These positions are with a rapidly expanding company and offer excellent opportunities for personal growth. Initiative and the ability to contribute ideas are essential qualifications for these appointments. Apply, giving a concise summary of qualifications and experience, to the Personnel Manager, Jensen-Salsbery Laboratories, Inc. (a subsidiary of Vick Chemical Company), 21st and Penn, Kansas City 41, Missouri.

POSITIONS OPEN

Experimental Psychology Assistantships. Animal studies. Use operant and Pavlovian conditioning techniques, treat data, maintain animals, assemble apparatus. On-job training. Salaries between $4000 and $5000. Inquire Chief, Experimental Psychology Laboratory, Creedmore Institute for Psychologic Studies, Queens Village 27, N.Y. 11/6

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Ph.D. essential, preferably in physical chemistry. Truly creative man with related experience in drug field. Please send detailed résumé in complete confidence. All replies will be acknowledged. Our employees know of this ad.

Box 239, SCIENCE

Pharmacologist, Ph.D., and **Biochemist,** Ph.D. Some experience helpful but not essential. Opportunities for creative research in growing, pharmaceutical laboratory. Close departmental relationship with creative chemical group. New laboratories to be completed in spring; some positions available now. Replies held confidential. Send résumés to Research Department, Irwin, Neisler & Co., Decatur, Illinois. 11/6

Postdoctoral Traineeship in Neurophysiology. Available for the Ph.D. in physics, biology, biochemistry or physiology or the M.D. who would like to broaden his training and enter research in nerve physiology. Stipends from $4500 per year and up plus dependent allowance. Facilities available for investigation involving mammalian neurophysiology and single vertebrate nerve fiber analysis. Write G. M. Schoepfle, Department of Physiology, Washington University School of Medicine, St. Louis 10, Mo. 10/16, 23, 30

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(a) **Parasitologst** for research with large pharmaceutical firm; biochemistry or nutrition experience desirable; $8000–$10,000; Midwest; (b) **Physiologist** for newly created psychopharmacology research team, California; (c) **Bacteriologist,** Ph.D. or M.S. degree and good clinical experience; take charge of active department in 300-bed hospital and teach technicians, California resort town; (d) **Biochemist** to initiate and supervise research on animal health products and feed medications and prepare new drug application material; Midwest; (e) **Biochemst,** Ph.D. degree with radioisotope experience for research with leading pharmaceutical laboratory, East. S10-5 Medical Bureau, Inc., Burneice Larson, President, 900 North Michigan Avenue, Chicago. X

FELLOWSHIPS

NATIONAL RESEARCH COUNCIL OF CANADA POSTDOCTORATE FELLOWSHIPS, 1960–61. Approximately 100 fellowships will be awarded for 1960–61 by the National Research Council. Of these, 40 will be tenable in National Research Council laboratories in Ottawa, Saskatoon, and Halifax, 10 in laboratories of the Canada Department of Agriculture, located at various centers, 10 in laboratories of the Canada Department of Mines and Technical Surveys in Ottawa and Victoria, 10 in laboratories of Atomic Energy of Canada Limited, and 30 in laboratories of Canadian universities.

Applicants should not be more than 35 years of age and should possess a Ph.D. degree from a recognized university, or expect to obtain such a degree before taking up an award. There are no restrictions regarding nationality of applicants, but successful candidates must meet all Canadian immigration requirements.

The annual stipend, which is free of income tax, is $3700 for single fellows and $4500 for male fellows who are married. An allowance towards the cost of travel is also paid.

The fields in which fellowships are available in the laboratories of the National Research Council, the Department of Agriculture, and the Department of Mines and Technical Surveys, are described in greater detail in booklets that may be obtained on request, together with application forms. Applicants who are interested in fellowships in the universities may write directly tot these institutions, or to the National Research Council for information. The fields of interest should be stated in the initial inquiry in order that appropriate information may be supplied. The closing date of the competition is **15 February 1960.**

Inquiries should be addressed to Awards Officer, National Research Council, Ottawa 2, Canada. X

The Department of Pharmacology, University of Buffalo School of Medicine, Buffalo 14, N.Y., offers a 4-year program of course work and research training leading to the Ph.D. degree. Research opportunities include the action of drugs on the kidney, the heart and circulation, the autonomic ganglia, and smooth and skeletal muscle. Annual stipends of $1800 to $2200 plus full tuition, plus $500 for each dependent. Applications now being considered for entrance February or September, 1960. Detailed information supplied on request. X

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GET YOUR ADVANCE COPY

of the General Program of the AAAS Chicago Meeting

by first class mail – early in December

The General Program of the 126th Meeting of the AAAS in Chicago, 26-31 Dec., 1959, will be available to you within the first week in December—whether you can attend the Meeting or not.

Effective this year, the former General Program-Directory, which had become an unwieldy book of more than 400 pages, has been separated into *two* publications, namely:

a) The Directory of AAAS Officers and Activities, 96 pp., already published; and
b) The General Program of the Annual Meeting, c. 200 pp., which will appear early in December

Both of these, sold at cost, may be purchased separately—in advance (see coupon below), or at the meeting. Some of their *respective* contents are:

The General Program

1. The two-session general symposium "Moving Frontiers of Science IV," arranged by the Committee on AAAS Meetings.
2. Programs of the 18 AAAS sections (symposia and contributed papers).
3. Programs of the more than 80 participating societies.
4. Sessions of the Conference on Scientific Communication, Conference on Scientific Manpower, and the Academy Conference.
5. The Special Sessions: AAAS Address and Reception, National Geographic Society, Phi Beta Kappa, Sigma Xi, RESA, Tau Beta Pi Association.
6. Details of the Morrison Hotel—center of the Meeting—and of the other session sites.
7. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
8. Exhibitors in the 1959 Annual Exposition of Science and Industry and descriptions of their exhibits.

The Directory

1. AAAS officers, staff, committees, for 1959.
2. Section committees and other AAAS Council members.
3. The 285 affiliated organizations.
4. Historical sketch and organization of the Association.
5. Complete roll of AAAS presidents and their fields.
6. Publications of the Association, including all symposium volumes.
7. AAAS Awards—including all past winners.
8. Future Meetings of the AAAS through 1963.
9. New and current activities of the AAAS.
10. Constitution and Bylaws.

Advance Registration

Advance registration has these decided advantages: 1) You avoid delay at the Registration Center upon arrival; 2) You receive the General Program in ample time to decide, unhurriedly, which events and sessions you particularly wish to attend; 3) Your name is posted in the Visible Directory as the Meeting opens.

The following coupon may be used both by advance registrants and by those who wish only the advance copy of the General Program; the Directory may also be ordered.

—THIS IS YOUR COUPON FOR AN ADVANCE COPY OF THE GENERAL PROGRAM— (AND FOR THE DIRECTORY, IF ALSO DESIRED)

1a. ☐ Enclosed is $3.00 for my advance Registration Fee which brings me the General Program, Convention Badge, and all privileges of the Meeting.

1b. ☐ Enclosed is $2.00 for only the General Program. (It is understood that, if I should attend the Meeting later, the Badge—necessary for the privileges of the Meeting—will be secured for $1.00 more.)

(Check 1a or 1b)

1c. ☐ Enclosed is $1.00 for the Directory of AAAS Officers and Activities to be sent now.

Total amount enclosed $.....

2. FULL NAME (Dr., Miss, etc.) .....
(Please print or typewrite) (Last) (First) (Initial)

ACADEMIC, PROFESSIONAL, OR BUSINESS CONNECTION .....

4. OFFICE OR HOME ADDRESS .....
(For receipt of General Program and/or Directory)

5. FIELD OF INTEREST .....

6. CONVENTION ADDRESS .....
(May be added later, after arrival)

Please mail this Coupon and your check or money order for the total amount to the
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
1515 Massachusetts Avenue, NW, Washington 5, D.C.

Kodak reports on:

microfilming brought down to the scientist's level . . . the restraining effect of our inhibitions . . . keeping the columns packed

Less than a laundry

Our subsidiary, Recordak Corporation, has recently come out with a portable microfilmer that weighs only 24 pounds and lists for only $845. If you fail to grasp what this has to do with science, we are wracked by ambivalent feelings toward you. On the one hand, we feel extra respectful in your presence; a mind so obviously unaccustomed to seek solace in gadgetry is scarce. At the same time, we want to turn you gently toward the light. Certainly you're not the type to seek your solace in paper-shuffling, but you have to prove that, if only to yourself.

Think for a moment like that fabled monster, the efficiency expert. His baleful eye casts about for concentrations of paper. When he sees information being extracted from one pile of papers for summary on yet another piece of paper, his mouth waters. When he sees some poor soul toiling at a task that could go undone but for the necessity of preserving proof of the finer details, he pounces. Our subsidiary, Recordak Corporation, watches from the bushes and purrs benevolently. Get the picture?

It all began in banks a generation ago, spread to department stores and phone companies, and in the last decade has reached enterprises like dry-cleaning establishments, dairies, and medical clinics. Now the idea of microfilming while summarizing has been brought down to the scientist's level. The Recordak Portable Microfilmer is of the right scale in size and cost for work of lesser magnitude (from Recordak's special viewpoint) than getting out the monthly statements of a prosperous laundry.

Documents are fed into the machine face up and returned face down in their original sequence. They are freed for other use, or they can be dumped and yet remain retrievable. They can be up to 12 inches wide and of any length. Reduction ratio is 20:1. Forty-six 8½″ x 11″ sheets can be microfilmed in a minute, smaller documents proportionally faster. Two 100-foot rolls of film can be exposed simultaneously to the same subject matter. Film units are readily removable so that "one subject" records can be kept separate even though microfilming be done intermittently.

Recordak Corporation, 415 Madison Avenue, New York 17, N. Y., has a nation-wide chain of branch offices and processing stations. It is just possible that your problem will remind the salesman of one he solved for the wholesale chicken business and that he will take you out and show you how it works there.

Color for facts, not kicks

If we wanted to, we could in good conscience call "S.O. 260" the fastest color film ever made. We don't want to.

There are other reversal color films you can expose on the assumption of an outrageously high index, force-develop, and obtain an image out of. All we're saying is that outrage for outrage, "S.O. 260" loses less in color saturation, maximum density, and fineness of grain than others. This advantage can be so important in data acquisition—flame studies, aerodynamic studies, attitudes of informatively painted flying objects, for example—that we had better not rely on rumor and word of mouth to spread the news of its existence.

This is not intended for the photo-hobbyist who gets his thrills by bragging to his buddies, "I shot this at an Exposure Index of 600."* Wise or foolish, we dislike to see him sacrifice the potentiality of pictorial excellence instead of contriving to put a little more light through his lens. Maybe it's none of our business, but such are our inhibitions. We draw to his attention *Kodak High Speed Ektachrome Film, Kodak Ektachrome Film* (*Process E-3*), *Kodak Ektachrome Film* (*Process E-2*), and *Kodachrome Film*, any of which can yield him beautiful and impressive transparencies.

"S.O. 260" currently takes the form of 16mm film with a perforation pitch of .3000″ in 100′, 200′, and 400′ lengths and 35mm film of .1870″ perforation pitch in 100′ and 400′ lengths. These are pitches for high speed motion picture cameras. If you recognize that and have a need for data from color changes (changes, *not so much the colors themselves*) *photographed under very unfavorable conditions, initiate an inquiry about "S.O. 260" with Eastman Kodak Company, Photorecording Methods Sales Division, Rochester 4, N. Y. You will be put in touch with the proper parties.*

They shall trickle!

Resolved that the chromatographic columns of western civilization shall not stand unpacked for lack of capital to invest in proper acid- and alkaline-purified cellulose ion-exchange adsorbents in full-pound minima, we make you this proposition—

For $2.75, 10 grams of *Cellulose-ECTEOLA* (Eastman 7798), useful in fractionation of DNA (*J.A.C.S.*, 80,6223).

For $4.35, 25 grams of *N,N-Diethylaminoethylcellulose* ("DEAE-cellulose," Eastman 7392), another anion exchanger recommended for such use.

For $2.75, 10 grams of *Carboxymethyl Cellulose Ether* ("CM-cellulose," Eastman 7796), a cation exchanger.

For $9.85, all three. Now you can afford to be a well-equipped sport. As ethers they are regenerable, even after use with strongly acid or basic solutions.

Send your order, please. We are waiting. Write to Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company). This is also where you write for a copy of Eastman Organic Chemicals, List No. 41, which catalogs some 3700 organic chemicals we have on hand.

*The fastest black-and-white instrumentation film we currently recommend for esoteric conditions of short exposure is often handled on the basis of an Exposure Index of 1600. It comes in 16mm, 35mm, and 70mm widths as *Kodak Royal-X Pan Recording Film.*

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

Prices are list and subject to change without notice.

Kodak
TRADE MARK